STUDY ON THE FOOD AND FEEDING BEHAVIOUR OF CROWS (*Corvus species*) AT ALIGARH DISTRICT AND THE IMPACT OF THEIR FEEDING HABITS ON AGRICULTURE

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IN PARTIAL FULFILMENT FOR THE DEGREE
OF

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IN

Wildlife Science

BY

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To my parents

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CERTIFICATE

This is to certify that the dissertation "Study on the food and feeding behaviour of crows (Corvus species) at Aligarh District and the impact of their feeding habits on agriculture" submitted for the award of M. Phil degree in Wildlife Science, of the Aligarh Muslim University, Aligarh, is the original work of Mr. Ashfaque Ahmed. This work has been done by the candidate under my supervision.

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Birds have manifold importance for the mankind. Many species serve us by devouring harmful insects and rodents (Pests of crops and orchards) and also play a significant role in the dispersal of seeds and the pollination of flowers. On the contrary some species cause substantial damage to the crops and fruits and also pose hazards to aviation. Recently a new field 'Economic Ornithology' dealing with the studies of benificial and inimical aspects of birds has emerged. To determine the economic status of a bird species detailed qualitative and quantitative studies on its food and feeding habits is essential. The knowledge of its life history and population dynamics are also required to ascertain its role. According to Hartley (1948) "the lack of fundamental ecological knowledge makes it impossible to pronounce upon the economic status of any species, save in a few very obvious cases".

In the past most of the Indian Ornithologists have limited their work in the field of taxonomy. Very little and scanty information is available on the food and feeding habits and other ecological aspects of even common birds. Ali and Ripley (1971).

In a developing country like India which is largely

dependent on its agriculture, it becomes very much essential to analyse the overall impact of the birds on the agriculture. We are striving hard to increase the agricultural production to combat the demands of our ever increasing population. But this can not be achieved if large proportion of the produce is to be consumed by the insect pests and graminivorous birds and other vermins at different stages of crop development viz. germination, seedling, harvesting and during storages. In the recent years the damage to the crops (maize, soyabean, jowar, bajra, wheat, rice etc.) and fruits (guava, mango, peach, almond) has been objectively analysed and documented by Beri et al. 1968, Ramzan and Toor 1972; 1973; 1975; Chopra et al 1972; Bhatnagar et. al. 1973; 1974; Srivastava and pareek, 1974; Toor and Ramzan 1974 a; 1974 b; Bhatnagar, 1975; Sinha et al. 1975; Ali et. al. 1976; Dhindsa and Toor 1980; Toor and Sandhu 1981; Ali et. al. 1982; Sandhu and Dhindsa 1982; Sarwar and Murti 1982. However as stated earlier these informations are scanty. on the other hand much progress has already been made on the economic role of birds in Europe and America, notably in Hungry, Great Britain, Soviet union and the United States of America. In India Mason & Lefroy (1912) commented on food habits of 110 species of birds by gut analysis of 1325 stomach contents collected at Pusa (Bihar). It added valuable information to the knowledge of the role of birds in agriculture and their economic

importance. Ali and Ripley, 1971,1983, has described the general food habits of all Indian species in their compact hand book of the birds of India and Pakistan.

Studies on the food habits of some Indian birds are by Hussain & Bhalla (1937, 1939) Bates, 1943 Ripley, 1954; Bump et. al. 1961; 1964; Christensen, 1961; 1964; Mukherjee, 1963; Abdul Ali, 1964. Samuel, 1949; recorded the Indian House Sparrow as a serious pest of orchard and wheat in Baluchistan (W. Pakistan). Faruqui et. al. (1957, 1960) studied the seasonal food of three species of game birds found in West Pakistan and India. Brown 1928, worked on the economic value of birds of Ceylon in which he classified birds into three categories, namely destructive (grain feeding birds), benificial (insectivorous birds), and game birds.

The majority of studies which have lead to either submission of a thesis of Ph.D. level or has resulted in the preparation of book have been undertaken by students or staff of foreign Universities. It is only recently that in some Indian Universities student have started working in this field. Comparatively the development of field research in birds is at a better stage now. This is largely due to the late Dr. Salim Ali's effort for associating the Bombay Natural History Society with the University of Bombay for field studies on birds' ecology. Field research

in ornithology goes back to 1950's (Daniel, 1986). He has mentioned the work of Kannan, 1966; Mathew, 1973; Panicker 1974; Grubh, 1974; Vijayan, 1975; khan, 1978; Priya Davidar 1979; Yahya 1980; Zacharias, 1984; Rahmani 1986.

Considering the gravity of the above mentioned situations Centre of Wildlife & Ornithology, Aligarh initiated a research project on the "ecology and breeding biology of some agriculturally important birds of Aligarh District". The overall aim of the project was to collect informations on the feeding ecology of the birds i.e. the food items, their number while feeding and the extent of damage caused by them.

Since the crows are found abundantly in Aligarh District, villages of Aligarh and in and around the A.M.U. Campus and have direct impact on agriculture their ecological studies on the food and feeding behaviour were carried out to find out the impact of their feeding habits on agriculture. The study was conducted with the following objectives.

(i) Studies on the feeding behaviour, quantitative and qualitative analysis on the damages caused by them to agricultural crops to determine the economic status of the birds.

(ii) Study of the dietary spectrum with special reference

to waste materials/filths in the food of the crows to ascertain its role in nature as scavenger.

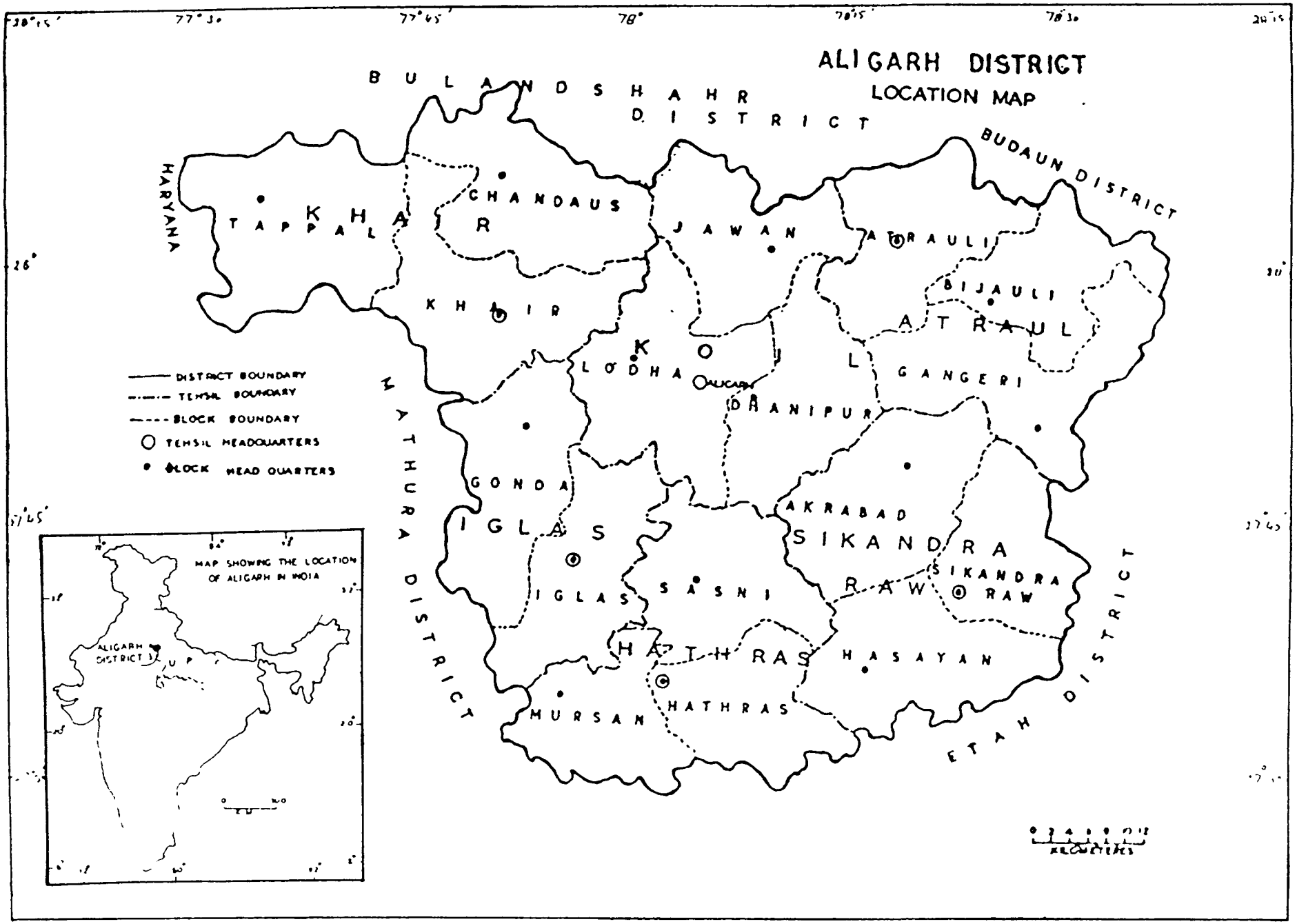
It is expected that the result of the present study will lead to a better understanding of the impact of these birds in agricultural fields. It is also believed that the present investigations will inspire the research workers and students to know more about these birds in future.

ALIGARH DISTRICT

The district of Aligarh lies in the upper Ganga-Yamuna Doab and may be considered as the most southerly of the upper Doab districts of Uttar Pradesh. It comprises the northern most portion of the Agra Division. It is bounded in the north by Bulandshahar district and in the south and south west by Mathura district. In the south east and east it borders the district of Etah, while the extreme north eastern boundary is formed by the Ganga which separates it from the district of Badaun. The Yamuna in the extreme north-east separates it from the Gurgon district Haryana. (Map 1)

LOCATION & BOUNDARIES

The district of Aligarh spreads from $27^{o}29'$ N to $28^{o}11'$N latitudes and $77^{o}29'$E to $78^{o}38'$E longitudes. The greatest width from west to east is about 116 km, and the maximum length from north to south is about 27 km. According to 1981 census the population of Aligarh district is 25,65,450, spread over an area of 5,028 sq.km. which gives it a density of about 418 persons per sq. km. About 67 percent of the total population is engaged in agricultural pursuits and lives mostly in rural areas. The urban


ALIGARH DISTRICT
LOCATION MAP
BULANDSHAHR DISTRICT
BUDAUN DISTRICT
HARYANA
ETAH DISTRICT
MATHURA DISTRICT
TAPPAL
KHAIR
CHANDAUS
JAWAN
ATRAULI
BIJAULI
ATRAULI
KOL
LODHA
GANGERI
DANIPUR
GONDA
IGLAS
IGLAS
SASNI
AKRABAD
SIKANDRA RAW
SIKANDRA RAW
HATHRAS
HASAYAN
MURSAN
HATHRAS
DISTRICT BOUNDARY
TEHSIL BOUNDARY
BLOCK BOUNDARY
TEHSIL HEADQUARTERS
BLOCK HEAD QUARTERS
MAP SHOWING THE LOCATION OF ALIGARH IN INDIA
ALIGARH DISTRICT
U.P.
KILOMETERS

MAP 1

population is 5,91,337 while the rural population is 19,74,113.

There are six tahsils in Aligarh district, namely Khair, Koil and Atrauli in the north, Hathras, Sikandra-Rao and Iglas in the South. These tahsils are further subdivided into seventeen blocks spreads over 1,769 villages.

PHYSICAL FEATURE

Aligarh district forms part of the Ganga plain. This plain is a depression between the Himalayas in the north and Deccan Plateau in the south. It has been filled with alluvium brought down by the Himalayan River. The deposition of this alluvium commenced after the final upheaval of the mountain and has continued all through the pleistocene upto present. (Wadia 1953) Geology of India P.385.

CLIMATE

Aligarh district, experiences tropical monsoon type of climate with its characteristic seasonal rythm marked by the north east and south-west monsoons. Since the Aligarh district is predominantly agriculture bond, it is convenient to divide the climate into the following four categories.

Winter

By the end of November the south west monsoon completely ceases and the district comes under the influence of high pressure belt, which develops over the plains owing to low temperatures. Thus the winds blow from the plains towards the sea. The beginning of this cold weather is marked by considerable fall in temperatures.

In January the maximum temperature is 21.7°C while the minium temp. is 7.2°C (Table 1). During the cold season the nights are very cold while the days are comparatively warmer and the mornings are foggy. The winds are very light and blow at an average speed of 32 km per hour. The skies are cloudy. At times there is light shower in cold months also. By February there is north-ward movement of the sun and the temperature rapidly rises.

The amount of rainfall caused by these disturbances is small and it is irregular and sporadic. The rainfall for the months of December, January and February is 22.32mm 9.3mm, and 0mm respectively. The average temperature, rainfall and humidity are given in Table 2 and Fig.1.2 In February, there is little change in weather except for an increase in temperature. Yet by the end of this month with the northward movement of the sun, temperature rapidly rises and the hot season begins.

TABLE - 1 :- MONTHLY WEATHER CONDITIONS AT ALIGARH DURING OCTOBER 1987 TO SEPTEMBER 1988.

MONTHS	TEMPERATURE °C			RELATIVE HUMIDITY (%)	TOTAL RAIN-FALL (mm)
	MAXIMUM	MINIMUM	MEAN		
October 1987	32.0 (30.7-36.0)	18.5 (15.8-26.0)	25.25	68	35.0
November 1987	29.6 (23.1-34.0)	13.9 (8.2-15.5)	21.75	66.4	2.0
December 1987	22.2 (16.8-27.0)	7.1 (4.2-11.5)	14.65	74.9	48.5
January 1988	21.7 (18.8-24.8)	7.2 (3.2-11.0)	14.45	84.5	1.6
February 1988	25.1 (18.3-28.3)	9.9 (6.5-13.0)	17.5	71.2	10.2
March 1988	30.6 (25.0-36.4)	13.2 (9.8-22.3)	21.9	62.5	25.2
April 1988	39.2 (35.0-42.4)	20.3 (13.3-26.5)	29.75	41.8	1.5
May 1988	42.9 (38.0-46.8)	26.2 (21.6-34.0)	34.55	38.2	1.86
June 1988	38.8 (29.9-45.5)	25.2 (21.2-29.4)	32.0	62.7	50.4
July 1988	33.6 (24.8-35.7)	27.2 (23.0-27.0)	30.4	85.5	315.27
August 1988	32.4 (25.7-36.1)	24.6 (22.5-26.5)	28.5	85.6	244.9
Sept. 1988	35.1 (26.6-38.9)	21.6 (21.6-27.0)	28.35	76.9	128.4

Figures in parenthesis indicate range.

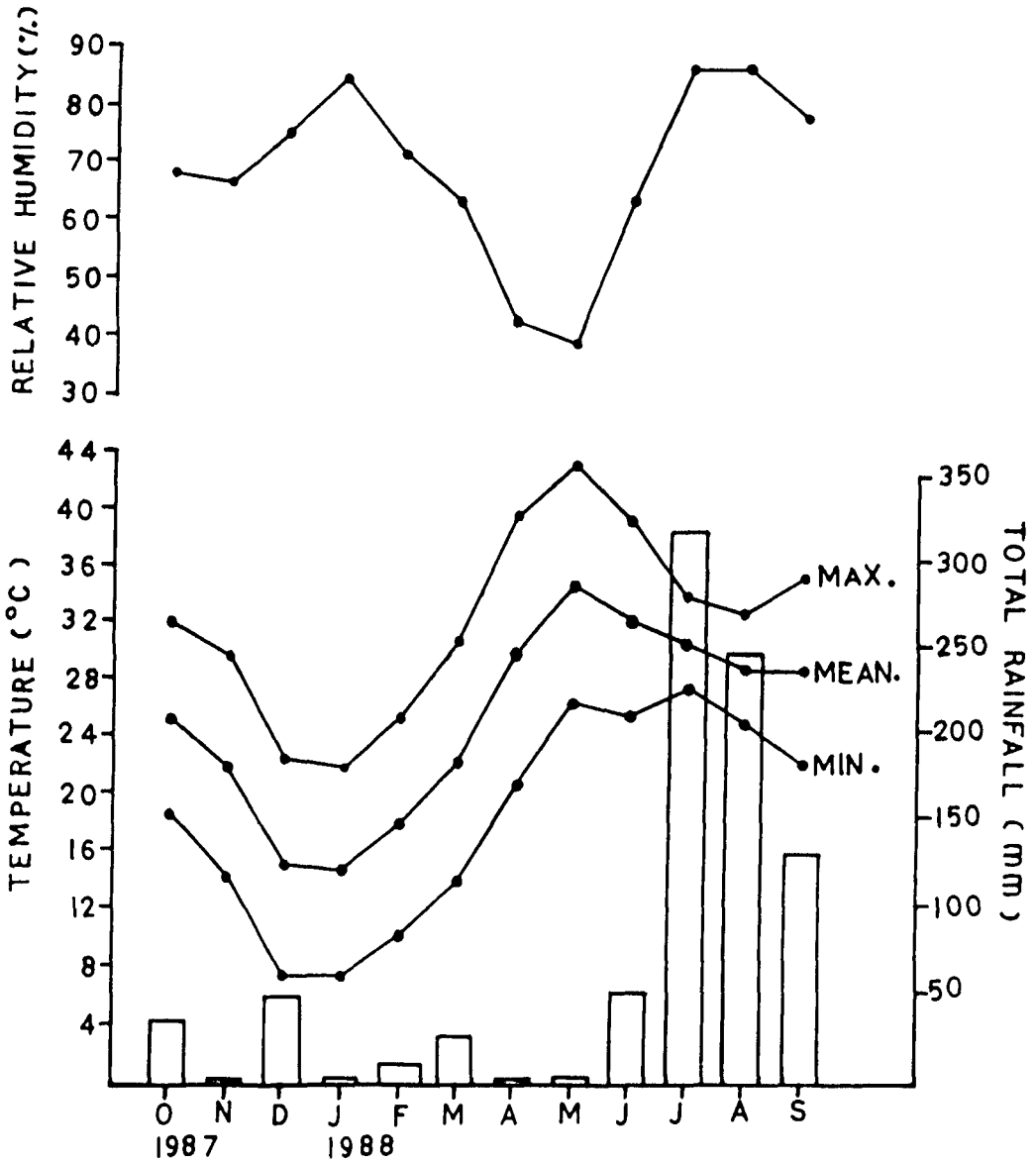


FIG. I.I METEOROLOGICAL DATA OF THE STUDY AREA DURING OCT. 1987 TO SEP. 1988

Summer

The summer starts from March and continues till June. Its beginning is marked by rise in temperature and decrease in pressure. The maximum and minimum temperature in March are 30.6°C and 13.2°C respectively. The months of May and June record exceptionally high temperatures. The maximum temperature rises to 42.9°C in May. The days are characterised by hot and dry air, the relative humidity being 38.2 & 38.58% in May Table (1 & 2),Fig.(1.1 & 1.2) and the nights are comparatively less hot. Hot dry winds, locally known as 'Loo' blow with great velocity during this period. It is maximum in June when its speed is 6.4 km per hour. The speed of these winds is maximum during the afternoon. Dust and thunder storms also occurs in the afternoon and it brings down the high temperature of the summer months. There is generally no rainfall during the summer months but these thunder storms, sometimes are accompanied by rains which was experienced in 1988.

Monsoon

On account of the excessive heat of the summer months low pressure area is developed in the north western India and by the middle of June, it brings a complete reversal in the air movement. With the arrival of the humid oceanic currents, the temperature falls and the air becomes cool. The maximum and minimum temperature in June falls from

TABLE - 2 :- MONTHLY WEATHER CONDITIONS AT ALIGARH DURING OCTOBER 1988 TO SEPTEMBER 1989.

MONTHS	TEMPERATURE °C			RELATIVE HUMIDITY (%)	TOTAL RAIN-FALL (mm)
	MAXIMUM	MINIMUM	MEAN		
October 1988	32.7 (30.4-35.3)	18.0 (15.9-25.5)	25.35	72.0	29.45
November 1988	29.4 (23.5-34.3)	13.2 (8.0-15.0)	21.3	73.0	1.5
December 1988	23.6 (17.7-28.5)	9.1 (6.0-13.4)	16.35	78.1	22.32
January 1989	20.1 (17.0-24.0)	7.2 (3.5-13.5)	13.65	80.09	9.3
February 1989	24.4 (20.5-35.3)	8.17 (12.5-17.5)	16.28	71.28	0
March 1989	30.27 (26.5-33.7)	13.41 (8.2-21.5)	21.84	68.29	30.38
April 1989	37.17 (29.9-41.0)	17.54 (11.5-28.3)	27.35	40.23	0
May 1989	41.62 (37.3-44.5)	24.96 (18.3-33.6)	33.29	38.58	6.2
June 1989	42.89 (35.0-43.3)	25.9 (21.5-31.0)	34.39	61.66	29.1
July 1989	36.34 (28.5-41.7)	25.46 (22.5-26.8)	30.90	76.09	456.32
August 1989	33.89 (26.3-35.0)	24.76 (22.5-26.0)	29.32	82.29	376.65
September 1989	34.09 (28.3-35.5)	23.76 (21.5-24.5)	28.92	83.47	129.0

Figures in parenthesis indicate range.

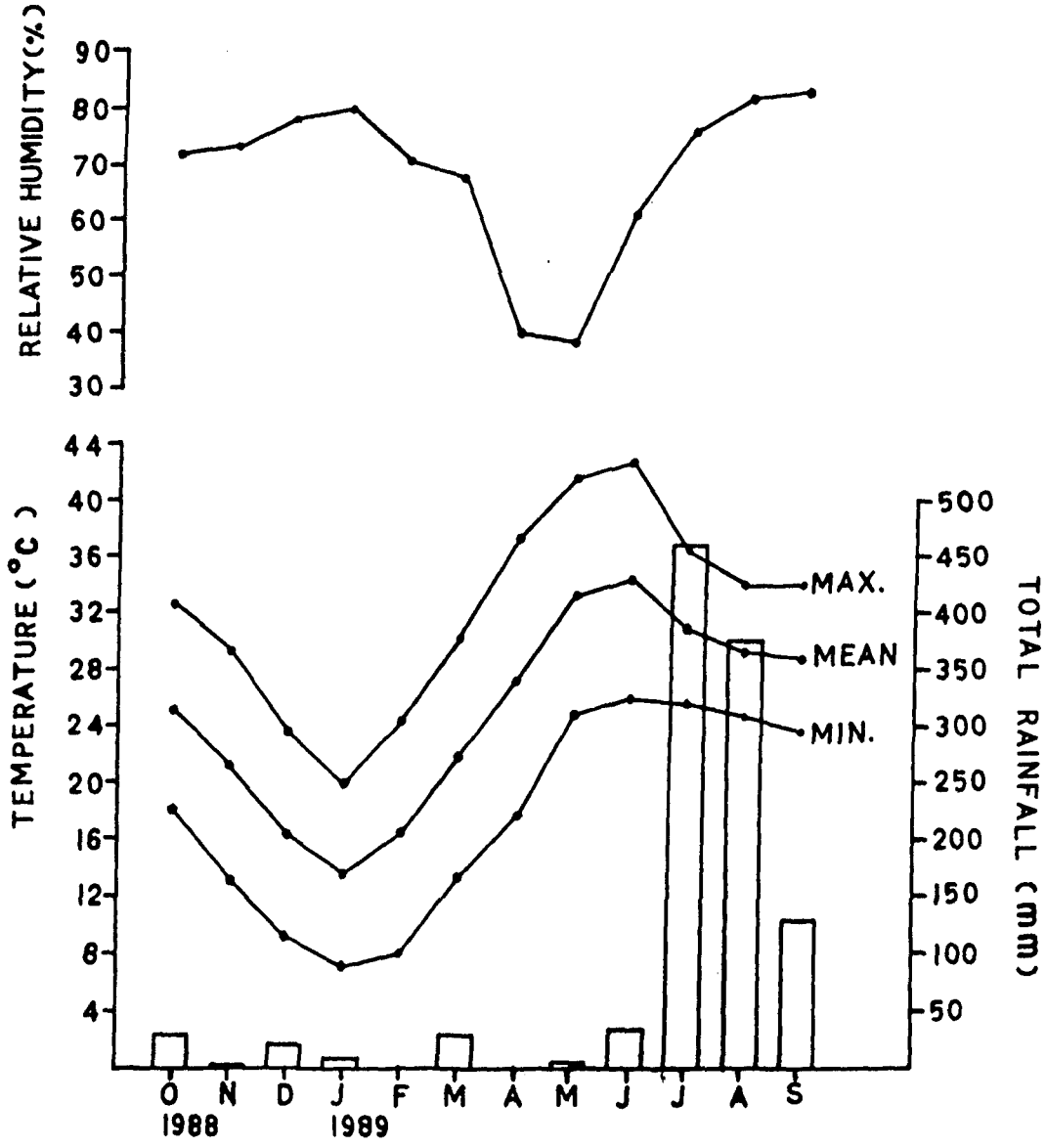


FIG. 1.2 METEOROLOGICAL DATA OF THE STUDY AREA DURING OCT. 1988 TO SEP. 1989

38.8°C to 25.2°C and in July from 33.6°C to 27.2°C. The relative humidity increases from 62.7 percent in June to 85.5 percent in July (Table 1&Fig1.1). The sky is generally overcast in the rainy season. The monthly distribution of rainfall throughout the district is not uniform. Usually the rainfall starts by the middle of June, remains steady in July and August and decreases by October.

Post Monsoon or Season of Retreating Monson

The withdrawl of the south west monsoon takes place usually by the third week of September. Rainless intervals become longer and the retreat of monsoon takes place by a series of intermittent rains and dry weather. With the recession of the monsoon there is a remarkable fall in precipitation. The weather during this period is characterized by clear skies and low humidity. The precipitation falls in October. As the sky clears and the sun shines, the day temperture slightly rises, while due to the dryness of the air, there is a slight decrease in the night temperature. By the end of october, the humid currents of the south-west monsoon are replaced by the dry continental winds. This is a period of transition from wet to dry weather. Usually this phase continues till the end of November, when the whole area comes under the influence of north-east monsoon.

SOIL

The soils of Aligarh district could be broadly classified under the head of alluvial soils. The alluvial soil group has been further divided into two broad geological subdivisions, the (i) old alluvium and the (ii) new alluvium.

The old alluvium locally called "Bhangar" is in the process of denudation by the new alluvium, known as "Khader" is in the process of building up. ICAR Hand Book of Agr. 1969.

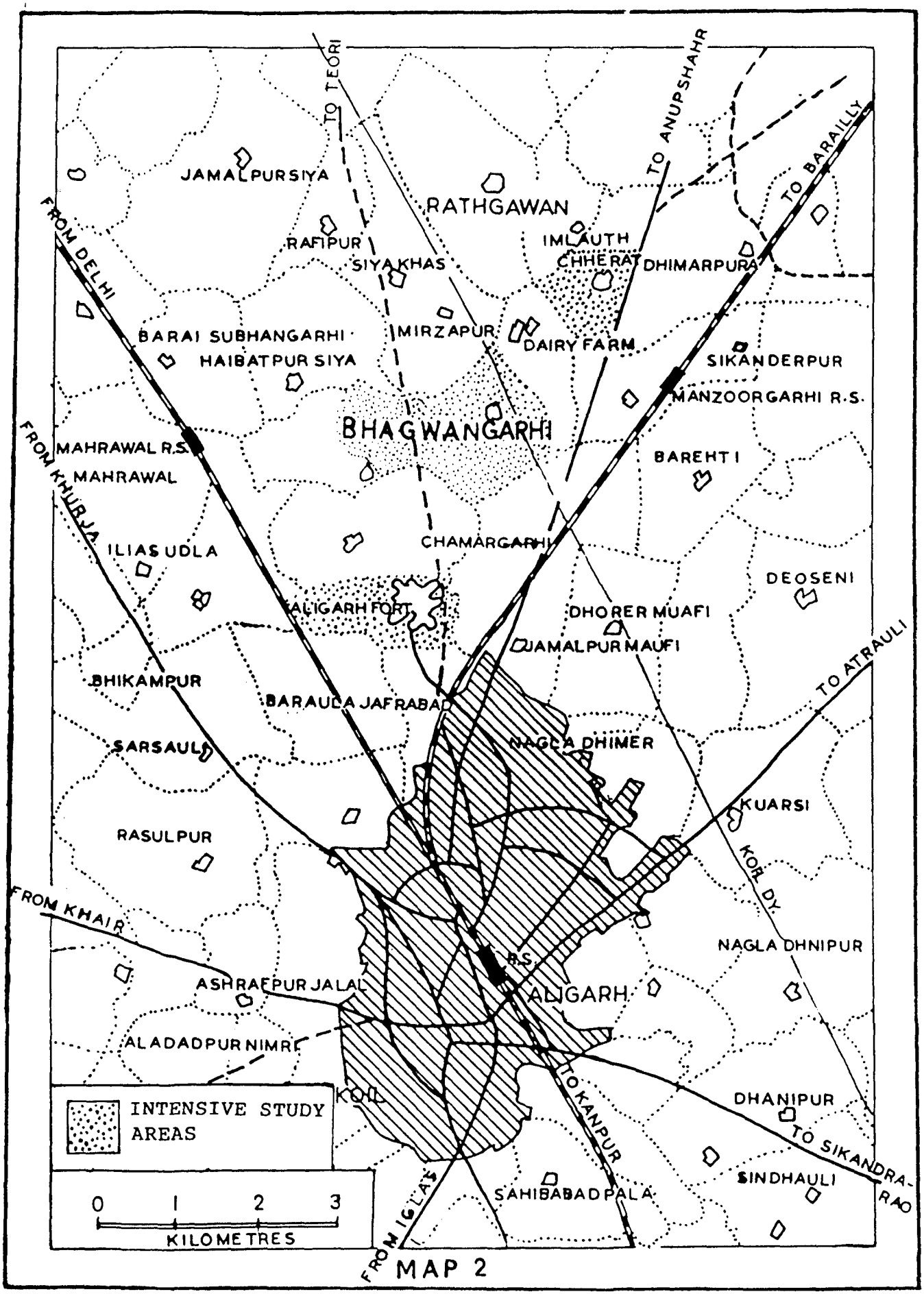
The soils differ considerably in their texture and consistency, ranging from sands through loams and silts to heavy clay that are ill-drained and sometimes are charged with injurious salts known as reh. The character and quality of the drainage exercises have considerable influence upon the quality and distribution of these soils.

INTENSIVE STUDY AREA

Universityfarm

It is situated within the area of Aligarh fort (Map 2 & 3). The fort of Aligarh stands some 3 km. to the north of the railway station. It is approached by a road branching off from that leading to Barauli. Tracing its history it would appear that the fort was originally

LOCATION MAP OF STUDY AREA



MAP 2

built in 1524 by Mohammad Khan, Governer of Koil under the Lodies. It was rebuilt in 1717 by the famous Sabit Khan. In 1737 it was taken by Jats. Under the supervision of De Boigue and Perron, the fort was reshaped by the agency of French Engineers and when stormed by Lord Lake in 1803, the fort appears to have the polygon of ten sides with a bastion at each angle. All round a broad and deep ditch, crossed at the entrance by a narrow causeway. Immediately after its occupation by the British the ditch was completed and the causeway was replaced by a draw bridge, and subsequently the outline was remodelled; the number of bastion being reduced to eight, while a second gateway was added on the north. During the recent years the area within the fort has been utilized as an agricultural farm by the University.

Bhagwangarhi

It is an agricultural village situated near about 6 km. to the north of the railway station. This area has been selected for the study because the area around is surrounded by human habitations and it is believed that the House crows as well as the Jungle crows are found in large number and depredate the crops and fruits of the area.

Map of A.M.U. campus

Roosting site of crows

MAP 3

Chherat

It is situated in $27^{o}28'N$ latitude and $78^{o}'E$ longitude. The central Diary farm is situated in this village. This area has been included in the study area because of two reasons:

(i) It is an agricultural village and one crow roosting site is very near from the agricultural field.

(ii) a road which goes to the Central Diary Farm bifurcates the land where the carrion and other filths like dungs and porks with skeleton are deposited. And also because this study site is too adjacent to the roosting site of the crows.

Other physical features of the intensive study area are similar as described above.The crows' roosting site at Chherat has been shown in Plate 4.

CROPPING PATTERN OF THE STUDY AREA

Cropping activities go on all the year round, provided water is available for crops. There are two distinct seasons. kharif (July to October) and Rabi (October to March). Crops grown between March and June are known as Zaid.

a. **Kharif** includes millet, jowar, maize, paddy, sunflower moong, urd, till, arhar, groundnut, cotton and kharif

vegetables.

b. Rabi includes wheat, barley, pea, gram, masoor, toria, rai, sarson and rabi vegetables.

c. Zaid includes moon, urd, sunflower, cotton and Zaid vegetable crops.

The main crops in Aligarh region are paddy, maize, jowar, bajra, wheat, barley, peas, gram and moong. Masoor and Rai/sarson are also grown but very little. These crops are grown sole or mixed (mixed cropping) or in a definite sequence (rotational cropping) or by two crops (double cropping) which may be grown in a year in a sequence.

Among these crops, the post monsoon crops (rabi) wheat, sorghum (rabi) and gram can also be considered to be the base crops for describing the cropping patterns. With such an approach, the crop occupying the highest percentage of the sown area of the region is taken as the base crops and all other possible alternative crops which are sown in the region either as substitute for the base crop in the same season or as the crops which fit in with the rotation in subsequent season, are considered in the pattern.

Kharif Season Cropping Pattern

Among the Kharif crops jowar, bajra & maize are

the prominent crops to be considered the base crops for describing the Kharif cropping patterns.

Kharif Jowar Based Cropping Pattern

Jowar is grown in this locality because the rainfall (distribution) ranges from 10-20 cm per month atleast for 3 to 4 months. Most of the alternative crops are also of the type which can be grown under medium rainfall. These alternative crops are cotton, pulses, groundnut, oilseeds and small millets.

Bajra Based Cropping Pattern

Bajra is a more drought-resistant crop than several other cereal crops and is generally preferred in low rainfall areas and on light soils. The area under bajra crops in Aligarh is about 11.23 q/h. This crop is grown in the areas receiving 10-20 cm rainfall per month extending over 1 to 4 months.

It has been observed that jowar and bajra are grown mostly under identical environmental conditions and both have a wide spectrum adaptibility in respect of rainfall, temperature and soil. Considering the cropping pattern in Utter Pradesh as a whole maize, rice and wheat form the main alternative crops to this crop.

Maize-Based Cropping Pattern

The area under the Kharif maize is 5.99 q/h. Taking the rainfall into consideration, over 72 percent of the areas receive 20-30 cm rainfall per month for atleast two months or more during the south-westerly monsoon season. In the maize growing areas rice in kharif and wheat in rabi are the main alternative crops. Bajra and rice may also be grown as alternative crops.

Rabi Seasons Cropping Pattern

Wheat together with jowar and gram are the main base crops among the rabi cropping pattern.

Wheat and Gram Based Cropping Pattern

These two crops are grown under identical climate and can often be substituted for each other. They are grown in areas having fairly high rainfall, over 20 cm to 30 cm, for atleast two out of the four months of the rainy season. Generally gram is grown on more moisture retentive soils, but with little irrigation or less rainfall. Here wheat, maize, jowar, millets and groundnut form the main crops preceding pulses and gram. Oilseeds and bajra are also grown as alternative crops. Table 3 summarizes the cropping pattern in this area. Table 4 presents the land

TABLE 3 : CROPPING PATTERN OF SOME COMMON CROPS OF ALIGARH REGION

Crops	Season	Sowing	Harvesting
Wheat*	Rabi	Oct.-Nov.	Mar.-Apr.
Rice	Kharif	May-June	Sept.-Oct.
Millet*	Kharif	July-Aug.	Nov.-Dec.
Pearl millet*	Kharif	July-Aug.	Nov.-Dec.
Maize*	Kharif	May-June	Sept.-Oct.
Pigeon pea	Kharif	June-July	Nov.-Dec.
Mustard	Rabi	Oct.-Nov.	Mar.-Apr.
Bengal gram	Rabi	Oct.-Nov.	Mar.-Apr.
Sweet pea*	Rabi	Oct.-Nov.	Feb.-Mar.

* Crops damaged by crows.

TABLE 4 : LAND UNDER DIFFERENT USE AT ALIGARH DISTRICT (1987-1989).

Land Types	1987-88 (Hectare)	1988-89 (Hectare)
Land used other than agriculture	40281	40160
Usar land	31929	33082
Waste land	9507	9297
Actual sown area	391362	390237
Area sown more than once	253670	260638
Complete sown area under:		
1. Kharif	228045	246589
2. Rabi	363485	356677
3. Zaid	53482	47595
Complete irrigated area under each crop :		
1. Kharif	96512	74530
2. Rabi	344357	346849
3. Zaid	52544	46436
Forest	971	808

Table 4 Continued:

Area under mixed crop :		
1. Jowar - Arhar	396	-
2. Bajra - Arhar	511	630
3. Kapas - Arhar	1113	705
4. Wheat - Barley	175	151
5. Barley - Gram	1560	2162
6. Wheat - Gram	244	352

Source : District Agriculture Department, Aligarh.

TABLE 5 : IRRIGATED AREA, TOTAL AREA, PRODUCTION AND AVERAGE YIELD OF SOME IMPORTANT CROPS OF ALIGARH REGION (Year : 1987-1989).

Crops	Irrigated land area (Hectare)		Total Area (Hectare)		Production (Metric-Ton)		Average yield (Kuintal/Hectare)	
	1987-88	1988-89	1987-88	1988-89	1987-88	1988-89	1987-88	1988-89
Rice (Kharif)	9943	9842	15566	14696	15706	23323	10.09	15.87
Maize (Kharif)	22270	32354	57039	58844	90001	61139	15.78	10.39
Bajra	1713	976	105859	78335	121738	69248	11.50	8.84
Jowar	546	458	2252	1466	1935	542	8.59	3.70
Wheat	220217	197807	220999	198504	546177	532528	24.71	26.83
Gram	8721	8660	13745	19502	13877	23387	10.10	11.99
Peas	18890	20365	19583	22037	23161	35451	11.83	16.09
Rice (Zaid)	9	5	9	5	9	8	10.09	15.87
Maize (Zaid)	112	89	112	89	170	108	15.21	11.17
Potato	-	4810	-	4818	-	62200	-	129.10
Total Rice (Kharif + Zaid)	9952	9847	15575	14701	15715	23331	-	-
Total Maize (Kharif + Zaid)	22382	32443	57151	58933	90171	61247	-	-

Source : District Agriculture Department, Aligarh

under different use in the district. And Table 5 elaborates production and average yield of some important crops of Aligarh region.

VEGETATION OF THE STUDY AREA

The vegetation of Aligarh is an arid open scrub, commonly known as Rakhs, under the classification made by Champion. This vegetation may be classified under the categories as under:

Perennial vegetation

Temporary vegetation

Perennial vegetation

It exhibits various degrees of xeromorphism. Stunted growth, succulence and thorny nature of plants are the most common features.

Temporary vegetation

On the onset of monsoon the entire ground floor is covered with a large number of herbs. These annual herbs complete their lifecycle within three to four months.

The negligible area (808 hectare) of the district is under forests. However various kinds of trees are found throughout the cultivated and uncultivated land. Different

species of tress have also been planted along the main road. The most common among them are neem Azadirachta indica Sheesham Dalbergia sissoo, Eucalyptus Eucalyptus globosa, Babool Acacia nilotica, Jamun Syzygium cuminii and Ashok polyalthia longifolia,. Though Siris Albizzia lebbek is not common but House crows were found feeding on the seeds of this tree.

A short list of these perennial and temporary vegetation has been given in appendix II. Wazahat (1970) has mentioned in more detail about the vegetation of Aligarh region.

Field studies pertaining to the food and feeding behaviour of the two species of crows viz., Corvus splendens and C. macrorhynchos were carried out during October 1987 to September 1989.

A survey of the region was first carried out to locate the intensive cultivated areas of Aligarh and the crow's roosting, nesting and main feeding site(s). After the survey University farm, Bhagwangarhi and Chherat were selected for the present study. These areas were choosen because the major crops (wheat, maize sorghum, and Pearl millet) of the region are grown every where in these selected areas; and crows' roosting sites are also situated close to the agricultural fields. These roosting sites are closely located at two places of the study area. One situated at S.S. House compound which is close to the University agricultural farm and the other is situated at central diary farm complex, near the Chherat.

These study areas are located with a radius of 7 to 8 km from the hall of residence (Sir Zeyauddin Hall). The areas were mapped and observations were carried out in relation to vegetation, cropping pattern and other ecological conditions. The meteorological data were collected from the nearest observatory at the campus

situated in the department of Physics. A detail description of these informations have been given in the previous chapter.

As improvised by Yahya (1980) observations were made in three shifts. Shifts may be classified as

6.00 hrs. to 10.00 hrs.	Shift I
10.00 hrs. to 14.00 hrs.	Shift II
14.00 hrs. to 18.00 hrs.	Shift III

The method adopted for assessing the population either in the field or at their roosting sites was by visual counting with the aid of binoculars wherever necessary.

The observations pertaining to their feeding behaviour, feeding association, feeding cycle, size of flocks and the general habits such as roosting, preening, bathing and mobbing were recorded. In final calculations equal no.of each shift was considered to minimise error.

A few crows were also shot with 0.22 air gun and the data on the morphometric characters and gut contents were recorded.

MORPHOMETRY:

The following ten characters of each freshly killed bird were measured as described by Baker and Moeed (1980) Dhindsa and Sandhu (1984) and Dhindsa et. al. (1985).

1. Bill length 2. Bill width 3. Bill depth.

4. Culmen 5. Pre-maxilla 6. Tarsus length.

7. Middle toe 8. Wing length 9. Tail length.

10. Body weight.

The information gathered on morphometry has been given in table -6

GUT CONTENT ANALYSIS

After recording the morphometric characters the guts (oesophagus and gizzard) of the birds were taken out, opened and the contents were put in sieves, washed, placed on a blotting paper and dried for 10 minutes at room temperature. Only the qualitative analysis of the gut could be recorded which had been presented in table-7.

DAMAGE ASSESSMENT ON CROPS

WHEAT & MAIZE ———————————— SEEDLINGS.

Four quadrats of 2 m x 2 m were selected randomly in each study area and the number of seedlings were counted in each as germination occured. The loss of seed was assessed from the first day of the germination. The observation continued for 21 days and the overall damage was calculated in percent loss. Out of four quadrats two of them were ribboned for experimental studies. This was done to examine

the effectiveness of ribbon and to compare the relative loss of the seedlings in control quadrats of the same size.

WHEAT——————————————————————————HARVESTING.

The damage to this crop was assessed only in 1988 and Chherat was selected for the studies. Four plots were randomly selected for sampling. From each plot 20 points were picked randomly and 5 earheads plucked from each point just before the harvest. These 100 earheads were examined to record the number of earheads damaged, number of grains lost to birds and the remaining grains perearhead. These grains were then weighed and expected weight of grains and the loss were calculated as summarised in the table 46

To know the involvement of different species depredating crop the area was visited periodically during the crop season and the depredatory species were recorded.

MAIZE, PEARL MILLET AND SORGHUM——————————HARVESTING.

Four sample plots were randomly slected in each study area for each of the above mentioned crops.

From each sample plot 10 points were selected randomly to examine the earheads surface destroyed by the birds just before the harvest. 10 earheads of each sorghum

and Pearl millet and 5 cobs of maize were examined from each point without removing them. The percentage of earheads surface destroyed by depredatory species was visually estimated and each earhead/cob was then assigned to one of the following categories.

I	No damage
II	less than 20% of the earheads surface damaged
III	20% - 40% damage
IV	40% - 60% damage
V	60% - 80% damage
VI	Above 80% damage.

While collecting the above data, some damaged earheads were also plucked at random from each plot of the study areas for detailed examination. Ten earheads/cobs (approximately of the same size) of each of the six categories were selected randomly from these plucked earheads. The mean number of grains per earhead of each of the five categories (II to VI) was compared with that of category I to calculate the average number of grains lost in that category. An equal number of grains lost in each category was removed from the undamaged earheads/cobs, weighed and the weight thus obtained were used as the values of all earheads falling in that (respective) category. The weight of grains damaged/earhead/cob in each category

was multiplied by the number of earheads/cobs damaged by visual estimation to get the total weight of grains damage in each category as summarized below in the table.

Category	Wt of grains damaged/earhed/ cob (n=10 for each category)	No.of earheads/ cobs damaged by visual estimation.	Total wt.of grains damage in each category
	d	n	p = dxn
I	d_1	n_1	d_1xn_1
II	d_2	n_2	d_2xn_2
III	d_3	n_3	d_3xn_3
IV	d_4	n_4	d_4xn_4
V	d_5	n_5	d_5xn_5
VI	d_6	n_6	d_6xn_6

STATISTICAL ANALYSIS

The data were subjected to various appropriate statistical analysis. Below is the description of variance - ratio test or F - test which is used for the test of significance and to examine the variation in damage due to replication years and due to the treatment among different agricultural farms.

The analysis of variance test (variance - ratio or F - test) is a technique to find out the relationship of the variation between the sample differences and the variation within the sample differences. The analysis of variance gives us a test to determine the significance of the difference between these two variances. To find the ralationship between these variances,we are required to find the variance - ratio. It is denoted by F. Thus, if χ_1^2 and χ_2^2 are two independent Chi-square variates with V_1 and V_2 d.f. respectively, then F - statistics is defined by

$$F = \frac{\chi_1^2/V_1}{\chi_2^2/V_2}$$

Since the same general characters are possessed by all samples similar methods are used for classification of data and analysis of variance. The value of variance - ratio or F can be computed as follows:

CALCULATIONS

a. The total damage in each plot was considered as a single observation. And since there are altogether 24 such observations, they were added to find out the grand total. It has been represented by G.

b. Correction factor was then calculated by squaring G and dividing it by total number of observations. This correction factor is denoted by C.F.

$$C.F. = \frac{G^2}{N}$$

c. Total sum of squares (TSS) of the table are obtained by

$$(\text{Add four values})^2 / 4 - \text{C.F.}$$

d. Replication SS (year) is obtained by squaring the total of 12 observations in each year, adding them, dividing by 12 and substracting them by correction factor.

e. Treatment SS (Farms) is obtained by squaring the total of 8 observations in each year, adding them, dividing by 8 and substracting them by correction factor.

f. Replication X Treatment SS = TSS of the table - Replication SS - Treatment SS

g. Total SS of entire data are obtained by squaring all the 24 observations, adding them and substracting by correction factor.

h. Analysis of variance table is set up as follows

Analysis of variance table:

Source of variation (SV)	Degree of freedom (df)	Sum of square (SS)	Mean sum of square (MSS)	Variance-ratio (F)
Replication (years)	1			
Treatment (Farms)	2			
Replication x Treatment	2			
Error	18			
Total	23			

where:

$$MSS = \frac{SS}{df}$$

$$F_{Replication} = \frac{MSS\ (Replication)}{MSS\ (Error)}$$

$$F_{Treatment} = \frac{MSS\ (Treatment)}{MSS\ (Error)}$$

RESULTS:

The value of F, thus obtained was checked at a 0.05 level of significance at (1,18) and (2,18) degrees of freedom.

TABLE - 6 MORPHOMETRIC MEASUREMENTS OF HOUSE CROWS
(n=6)

S.No.	Character									
	Bill length (mm)	Bill width (mm)	Bill depth (mm)	Culmen (mm)	Pre-maxilla (mm)	Tarsus length (mm)	Middle toe (mm)	Wing length (mm)	Tail length (mm)	Body weight (gm)
1.	49	20	18	43	21	49	29	249	140	170*
2.	56	26	23	49	22	51	41	276	169	305
3.	56	25	23	47	22	54	42	285	171	-
4.	51	25	22	47	22	52	42	282	171	297
5.	54	26	21	49	23	52	41	284	173	285
6.	53	25	22	48	22	51	43	283	175	304

* Young bird- Ist year.

FEEDING HABITS

There is probably nothing in nature that is edible, is not eaten by crows. This way they have been able to utilize most of the food resources available in and around their habitat.

It was observed that the crows do not search for food in a closed flocks. Scattered individuals covering large area cruise up and down in the air searching for potential food or feeding areas. Small quantitites of food discovered by a crow are usually consumed without vocal anouncement. But when a crow finds a large supply it instantly utters a special "food finding call" audible to other crows. All crows within range hasten to eat and they too broadcast the call. Sometimes descending flight performed when a cruising crow discovers food is also recognised by other crows as an indicator of possible food on the ground.

HOUSE CROW

The House crow lives almost in parties feeding practically everything that is eatable. The recorded items include grain, ground nut, fruits, eggs and young or sickly birds. The House crow is known to be very destructive in heronries and also systematically marauds Baya nests in

colonies. They also eat lizards, small rodents, fish, insects, crabs, kitchen scraps, garbage, offal and carrion. In cultivated areas the bird preferably feeds on injurious insects of the order orthoptera, Hymenoptera and Heterocera. Along with the injurious insects to crops it also feeds on the food grains and the fruits. But its habit of eating garbage, carrion, offal and removing filths and wastes definitely puts it on a higher platform than that of a vermin. The scavenging habit that it has, makes it a fairly useful organism of the urban and rural areas.

JUNGLE CROW

As mentioned by Ali (1975,1983) the Jungle crows eat practically all embracing animal as well as vegetable matter. The recorded items given by Ali & Ripley (1983) include carrion, garbage, offal, eggs, young and sickly birds, chick of poultry, rats, mice squirrels, lizards, frogs, land and sand crabs, centipedes and insects (dung and other beetles, locusts, grass hoppers, moths, ants, winged termites, catter pillars etc.). This bird also eats wild and orchard fruits, cereal grains,flower nectar and petals.

FEEDING ASSOCIATIONS

Interspecific and intraspecific association in birds feeding at a common feeding ground have interesting

relationships (Rand 1954). These relationships may be competitive,co-operative or symbiotic. The most common feeding association is the intraspecific flocking of a single species. But quite often, the feeding flocks are interspecific also. Such mixed feeding flocks vary from small to large number of birds belonging to different species. The interspecific flocking suggests that the co-operative food finding is advantageous, avoiding duplicate effort in food finding and satisfaction of gregarious tendencies.

There are numerous associations in which one species exploits another species as a "beater" to stirup its food For example drongos attach themselves to flocks of babblers and feed on the insects flushed by the latter. In ponds the insects dislodged by diving vegetarian coots are eagerly seized by carnivorous grebes. These are the examples of commensal relationships in which two species eat together, neither at the other expense. The effectiveness of exploiting beaters was shown by Dinsmore (1973) who determined that Cattle Egrets, Bubulcus ibis are about 3.6 times more efficient in capturing food when foraging with cattle or behind moving agricultural machinery than foraging alone. Such gastronomic profits explain the flocks of crows that follow the farmers tractor during ploughing. Closely related to commensalism are symbiotic relationships in which two, species each benefit from the others presence, as in the case of tick-birds that eat ticks on the mammals.

DAILY FEEDING CYCLE

Although the crows are light weight animals, their food requirements are substantial. They expend a considerable amount of energy to procure the food. As given by (W. Meise,1975), in Grzimek's vol.7, Birds I.They need between one sixth to twice as much food per day as their body weight and undertake long flights to find the food. In order of shift wize observation(page no.31), they have two very active feeding sessions and one less active session during a complete day. The first session of peak feeding hours is from 6.00 hrs. to 10.00 hrs. The next session of active feeding starts from 15.00 hrs. to 18.00 hrs. They are less active in feeding during 10.00 hrs. to 14.00 hrs. Fig. 2 . The crows start searching food as soon they leave their roost and also arrive to their roosting site as they finish their feeding business. The feeding activity of the crows are also correlated with the days length and the light intensity apart from food availability.

SIZE OF FLOCKS

The size of flocks of House crows as well as Jungle crows varies with a number of factors:-

(i) food item

(ii) the available food areas

(iii) arrival & departure from roost site and

(iv) the time of a day.

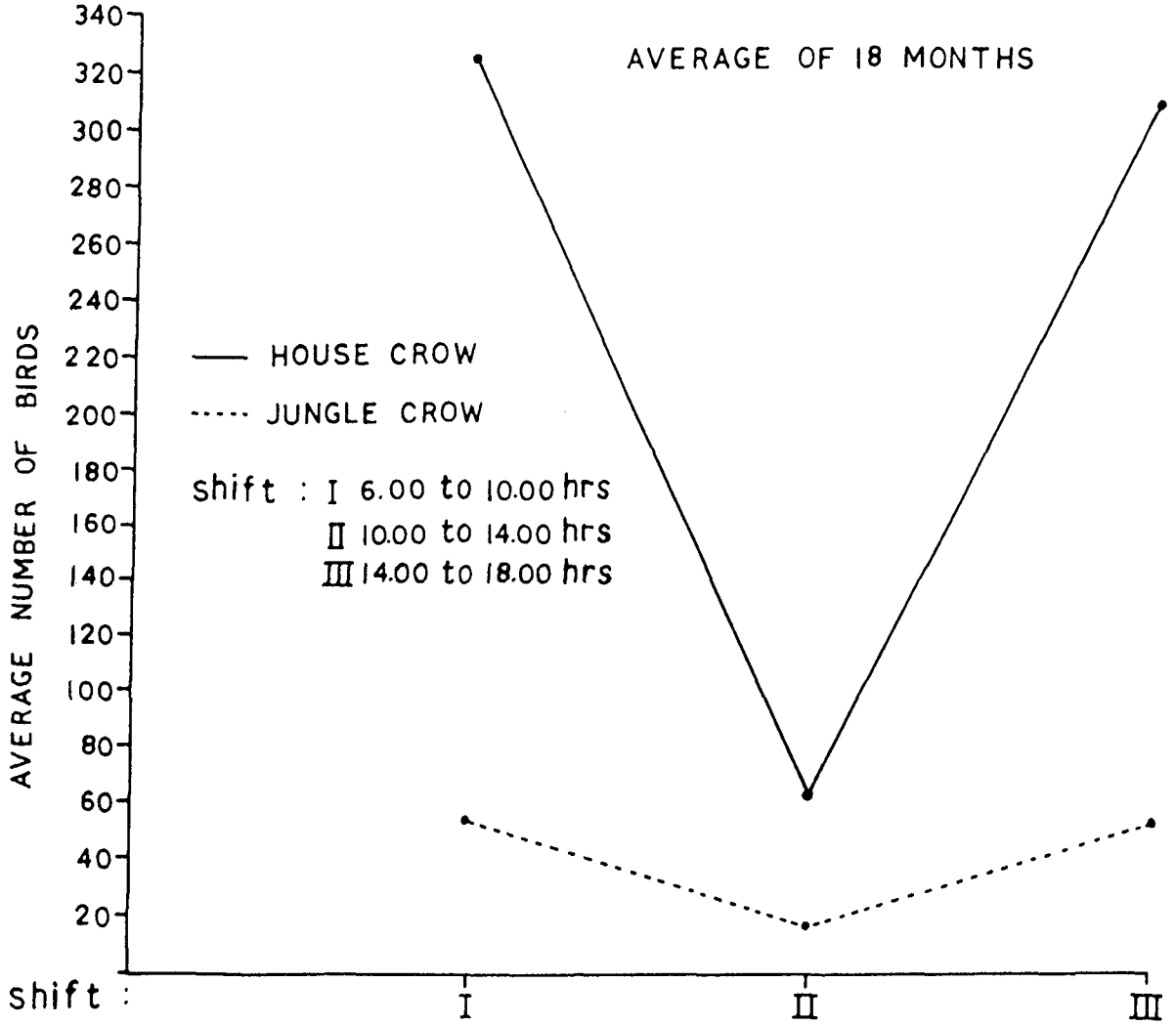


FIG. 2 DAILY FEEDING CYCLE OF CROWS

(i) Food item: When the food occurred in the form of crops, depredating flock of House crows recorded in a flock of 5-35 individuals perching on a wire or nearby trees. Among them the flocks of 2-10 invaded the crop. Jungle crows were only occassionally found in parties. They were more often observed alone.

(ii) The available food areas: When the areas were large and had enough food it could accomodate thousands of crows. This was recorded in garbage dump. The flocks were composed of 10-15 groups of 30-100 individuals in each group. On the contrary the flock of jungle crows consisted 5-6 groups comprising of 10-25 birds.

(iii) Arrival & departure from roost site: The crows arrive from different directions in parties of 5-30. Lone crow and pairs were also observed approaching the roost but this did not happen very often. While dispersing from roost they generally fly off singly. No communal roost site of jungle crow was found within the study area.

(iv) The time of a day: The crows were not found very active in the noon. They generally take rest during this period by perching on trees or wires. When found feeding, the number of birds in the flock was minimal comprising of 2-10 individuals.

GENERAL HABITS

Roosting behaviour:

The roosting behaviour in crows is a fabulous phenomenon. It is an striking sight to observe the convergence of more than thousand crows on the communal roost. According to my visual estimation C. 1600 and C. 1200 crows settle in the communal roost at Chherrat and S.S. House Compound respectively. At S.S. House the crows arrive from different directions in parties of 5 to 30. Lone crow and pairs were also observed approaching the roost but this happened very occasionally. At Chherrat they were observed approaching roost site in parties of 100 to 150. This was because the garbage dump is situated very close to their roosting site and they had not to cover a long distance after they finished their feeding. The crows after arriving at the roost give a loud call which becomes louder as more crows arrive. Almost all indulge in loud vocalization. These vocalization continues till it gets dark. The vocalizations reduce and the type of call also changes considerably with the darkness. In moonlit nights occasional calls from roost site are not uncommon. They also call when disturbed by some predator or rain or any other source.

Preening:

It is probably the most important as well as the

most frequent activity for plumage care. This is performed by bill. According to pettingill Jr. (1985) usually the bird deals with one feather at a time, seizing it at the base between the mandibles and working toward the tip, either nibbling it continuously or drawing it through the mandibles in one movement. This serves to clean the feather, to interlock barbs that have become separated and to smooth down the plumage. Allopreening was also observed. This generally takes place among pairs. It was observed frequently during breeding season.

Bathing:

This activity is frequent in summers. The birds were observed going into shallow water, first dip their throats and breast's and flap their wings up and down, then raise their heads and fore parts and lower their tails and hind parts into the water and flap their wings in and out of the water; at times splash water over the back. Water is sprayed over their plumage which is ruffled so that water can reach all the feathers, then gives a few shakes after coming out of the water and have a thorough preening. The crow used to take bath in a group of 5-6 and were found largely peaceful while bathing. These preening and bathing are considered as maintenance activities.

Mobbing behaviour:

This is a very characteristic feature on the roost and near the nesting site. The crows collect in large numbers on the ground or in air giving out loud calls. The function of mobbing is puzzling. Possibly it serves to put all birds in an area on the alert. This was observed frequently during the breeding season to distract a predator from the nest, on the presence of any other type of danger and when one of their clan was in distress. It was frequently observed that the House crows mob at any larger predator such as Pariah Kite, Shikra and Owls. At times they mob at & drive out any stranger bird in the area. On one occassion Dr. Yahya observed several House crows mobbing & killing a common Grey Horn bill at Aligarh (Personal Communication). Interaction of crows and Koels (Eudynamys Scolopacea) has been elaborately described by Baker (1934).

Feeding behaviour

The crows are euryphagous. They show varying degrees of adaptations to the foods they eat. It is also true that they have no great specialization for any particular food and are well known for their indiscriminate diet. The basic feeding adaptations of these species lie in its acuteness of sense organs, psychological bent, character of beak and tongue, shape and strength of feet, physiological tolerance of high and low temperatures and tolerance thresholds of certain food ingredients such as toxins, acids and salts Welty (1979).

Two species of crows were observed in the field and found that apparently they had a similar feeding habits. They exploit enormous diversity of food types (seeds, fruits, insects, offal, carrion and garbage). But the range of exploitation to the above food types by these species differ significantly. House crows comparatively feed on the seeds and crops most frequently and are found more in numbers whereas Jungle crows feed less frequently and are found very few in numbers. Although they also utilize offal, carrion, and garbage with similar fashion and almost with same frequency, however, the number of Jungle crows

observed removing these filths was always found low. The feeding habits of House crow as well as Jungle crow though observed simultaneously, but the following description about the damage assessment of crops and birds relation to agriculture refers to House crows mainly. It is because the Jungle crows were found to be very few in numbers and very occasionally fed on a few grains of the crops. An overall damage by different species of birds to different crops were also observed and described under separate headings.

Damage assessment on sorghum by crows

It is evident from the table 8 and Fig. 3 that the damage caused by crows to mature sorghum during 1988 ranges between 128.22 gm and 288.15 gm whereas the damage in 1989 lies between 142.04 gm and 273.47 gm. These damages are per 100 earheads of this crop. In both the years maximum damage was recorded at Chherat, medium at Universityfarm and minimum at Bhagwangarhi (Table 9,10 and 11). F - statistics (Table 12) indicate significant variation in the extent of damage among different agricultural farms ($F_{2,18}$=8.62, P=0.05) while the variation is insignificant due to replication years ($F_{1,18}$=0.10, P=0.05).

These differences in the extent of damage is due to variation in the number of crows visiting this crop (Table 13), and also due to their varying intensity of

TABLE - 7 :- DIET COMPOSITION OF THE GUT OF HOUSE CROW.

FOOD ITEM	GUT NO.					
	1	2	3	4	5	6
Rice grains	2	-	-	-	1	3
Wheat grains	1	-	4	-	2	5
Guava seeds	-	2	-	-	7	-
Beetles	+	-	+	-	+	+
Ticks	+	-	+	+	+	+
Egg shells	+	+	+	-	+	+
Bones	+	-	-	+	+	-

Figure denotes the actual number, - shows the absence and + indicates the traces of the food.

TABLE - 8 :- TOTAL DAMAGE OF SORGHUM (Sorghum vulgare) IN gm/100 EARHEADS IN EACH PLOT AT DIFFERENT AGRICULTURAL FARMS.

DAMAGE BY CROWS

PLOTS	AGRICULTURAL FARMS					
	UNIVERSITYFARM		BHAGWANGARHI		CHHERAT	
	1988	1989	1988	1989	1988	1989
A	147.80	206.60	132.94	175.37	245.40	273.47
B	128.22	164.79	176.99	211.68	288.15	196.49
C	170.44	201.19	175.52	163.94	235.43	269.27
D	251.60	208.39	198.45	142.04	214.63	207.59
$\bar{X}$	174.51	195.24	170.97	173.25	245.90	236.70
S.E.	±23.47	±8.89	±11.88	±12.60	±13.39	±17.45

DAMAGE BY DIFFERENT BIRD SPECIES

PLOTS	AGRICULTURAL FARMS					
	UNIVERSITYFARM		BHAGWANGARHI		CHHERAT	
	1988	1989	1988	1989	1988	1989
A	703.81	825.24	487.57	666.83	915.47	1116.88
B	557.84	574.89	639.17	798.50	1013.79	1135.12
C	758.07	770.36	657.96	620.93	853.02	1012.98
D	865.46	845.03	751.31	531.92	831.83	826.72
$\bar{X}$	721.29	753.88	634.00	654.34	903.52	1022.92
S.E.	±55.42	±53.44	±47.30	±48.24	±35.34	±61.24

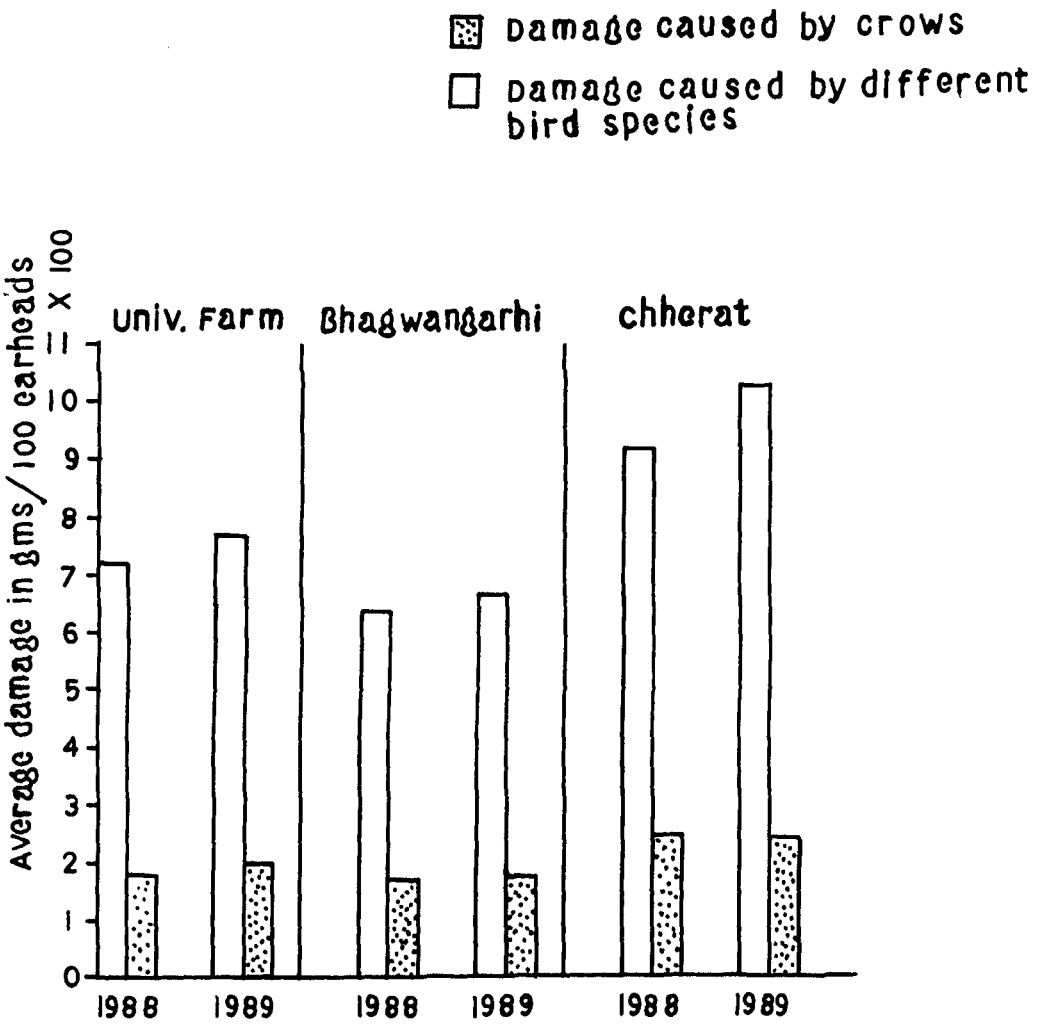


FIG. 3 AVERAGE DAMAGE OF SORGHUM IN gms/ 100 EARHEADS IN DIFFERENT AGRICULTURAL FARMS DURING 1988 AND 1989

TABLE - 9 :- SHARE OF DAMAGE BY HOUSE CROWS IN THE TOTAL LOSS OF SORGHUM (Sorghum vulgare) IN gm/100 EARHEADS IN DIFFERENT PLOTS AT UNIVERSITYFARM.

YEAR:1988

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	55	0	0	59	0	0	53	0	0	40	0
II	1.29	13	16.77	1.52	12	18.24	1.06	9	9.54	1.95	11	21.45
III	2.41	9	21.69	2.62	13	34.06	2.89	15	43.35	3.05	16	48.80
IV	3.29	8	26.32	3.05	7	21.35	3.62	12	43.44	3.89	10	38.90
V	4.78	11	52.58	5.19	6	31.14	5.81	6	34.86	5.65	18	101.70
VI	7.61	4	30.44	7.18	3	23.43	7.58	5	39.25	8.15	5	40.75
Overall damage:			147.80			128.22			170.44			251.60

YEAR:1989

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	53	0	0	57	0	0	40	0	0	43	0
II	1.62	12	19.44	1.49	10	14.9	1.08	12	12.96	1.31	14	18.34
III	3.05	6	18.30	2.83	13	36.79	2.65	15	39.75	2.85	13	37.05
IV	4.11	9	36.99	4.61	7	32.27	3.89	21	81.69	4.08	12	48.96
V	6.17	13	80.21	5.99	9	53.91	4.62	7	32.34	4.76	6	28.56
VI	7.38	7	51.66	6.73	4	26.92	6.89	5	34.45	6.29	12	75.48
Overall damage:			206.60			164.79			201.19			208.39

d = Wt. of grains damaged/earhead in each category
n = No.of earheads damaged by visual estimation/100 sampled.
p = Total wt. of grains damaged in each category.

TABLE - 10 :- SHARE OF DAMAGE BY HOUSE CORWS IN THE TOTAL LOSS OF SORGHUM (Sorghum vulgare) IN gm/100 EARHEADS IN DIFFERENT PLOTS AT BHAGWANGARHI

YEAR:1988

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	57	0	0	53	0	0	47	0	0	54	0
II	1.036	13	13.39	1.15	12	13.8	1.08	15	16.02	1.05	11	11.55
III	2.59	19	49.21	2.62	17	44.54	2.31	19	43.89	2.81	9	25.29
IV	4.75	4	19.00	5.02	7	35.14	4.73	8	37.84	4.98	9	44.82
V	5.32	2	10.64	6.19	5	30.95	6.09	6	36.54	6.22	12	74.64
VI	8.14	5	40.70	8.76	6	52.56	8.21	5	41.05	8.43	5	42.15
Overall damage:			132.94			176.99			175.52			198.45

YEAR:1989

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	52	0	0	51	0	0	56	0	0	61	0
II	1.18	15	17.7	1.71	14	23.94	1.51	16	24.16	1.31	13	17.03
III	3.05	12	36.60	2.95	9	26.55	2.43	10	24.30	2.62	11	28.82
IV	4.91	9	44.19	5.15	7	36.05	4.67	5	23.35	4.93	7	34.51
V	5.62	8	44.96	6.22	11	68.42	6.15	7	43.05	6.63	4	26.52
VI	7.98	4	31.92	7.09	8	56.72	8.18	6	49.08	8.79	4	35.16
Overall damage:			175.37			211.68			163.94			142.04

d = Wt. of grains damaged/earhead in each category
n = No.of earheads damaged by visual estimation/100 sampled.
p = Total wt. of grains damaged in each category.

TABLE - 11 :- SHARE OF DAMAGE BY HOUSE CROWS IN THE TOTAL LOSS OF SORGHUM (Sorghum vulgare) IN gm/100 EARHEADS IN DIFFERENT PLOTS AT CHHERAT.

YEAR:1988

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	44	0	0	33	0	0	49	0	0	56	0
II	1.15	12	13.80	1.33	12	15.96	1.45	16	23.20	1.48	9	13.32
III	2.72	10	27.20	2.85	19	54.15	3.12	12	37.44	3.71	12	44.52
IV	4.68	9	42.12	4.73	17	80.41	4.85	8	38.80	4.37	11	48.07
V	5.88	17	99.96	6.41	8	51.28	7.29	6	43.74	6.89	5	34.45
VI	7.79	8	62.32	7.85	11	86.35	10.35	9	92.25	10.61	7	74.27
Overall damage:			245.40			288.15			235.43			214.63

YEAR:1989

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	42	0	0	52	0	0	38	0	0	50	0
II	1.65	9	14.85	1.49	8	11.92	1.31	12	15.72	1.41	14	19.74
III	3.11	17	52.87	2.82	15	42.30	3.16	23	72.68	2.91	13	37.83
IV	3.98	13	51.74	4.73	17	80.41	4.98	12	59.76	4.62	11	50.82
V	5.51	7	38.57	6.48	5	32.40	6.73	8	53.84	6.65	7	46.55
VI	9.62	12	115.44	9.82	3	29.46	9.61	7	67.27	10.53	5	52.65
Overall damage:			273.47			196.49			269.27			207.59

d = Wt. of grains damaged/earhead in each category
n = No.of earheads damaged by visual estimation/100 sampled.
p = Total wt. of grains damaged in each category.

TABLE - 12 ANALYSIS OF VARIANCE - ANOVA FOR THE INVESTIGATION OF VARIANCES IN THE EXTENT OF DAMAGE TO SORGHUM BY CROWS.

	Farms			
Years	Universityfarm	Bhagwangarhi	Chherat	Total
1988	698.07	683.9	983.61	2365.58
1989	780.97	693.03	946.82	2420.82
Total	1479.04	1376.93	1930.43	4786.4

G = 4786.4 N = 24

C.F = G^2/N = 954567.71

TSS of the table:

1988	487301.72	467719.21	967488.63	1922509.6
1989	609914.14	480290.58	896468.11	1986672.8
Total				3909182.4

TSS of the table	=	22727.89
Replication SS(year)	=	127.14
Treatment SS(Farm)	=	21689.23
(Replication x Treatment)SS	=	911.52
TSS of entire data	=	45354.89

ANALYSIS OF VARIANCE TABLE

Source of variation (SV)	Degree of freedom (df)	Sum of square (SS)	Mean sum of square (MSS)	Variance-ratio (F)
Replication (years)	1	127.14	127.14	0.10
Treatment (Farms)	2	21689.23	10844.61	8.62
Replication x Treatment	2	911.52	455.76	
Error	18	22627.01	1257.05	
Total	23	45354.89		

Results: $F_{1,18}$ = 0.10 , P = 0.05

$F_{2,18}$ = 8.62 , P = 0.05

TABLE - 13 :- NUMBER OF CROWS OBSERVED AROUND THE CROP FIELD OF SORGHUM AND THE NUMBER OF VISITANTS INFESTING THE CROP IN VARIOUS STAGES.

SPECIES AND POPULAR NAME	CORVUS SPLENDENS HOUSE CROW		CORVUS MACRORHYNCHOS JUNGLE CROW	
STAGES OF CROP DEVELOPMENT	1988	1989	1988	1989
Fruit setting	326/00*	217/00	107/00	57/00
Milky/Doughy	421/103	312/116	55/07	49/13
Ripening	289/161	344/231	79/19	81/14
Harvesting	205/146	251/185	189/11	53/09

* Upper figure in each column denotes the number of birds observed around the crop field and the lower figure indicates the number of bird visitants infesting the crop.

depredation at different places of study. The maximum damage in Chherat is due to the roosting site of crows near the agricultural farm.

Damage assessment on sorghum by different bird species

The damage to sorghum inflicted by different bird species is indicated in the tables 8,14,15,16 and in the Fig.3. It ranges between 487.57 gm and 1135.12 gm per hundred earheads during 1988 and 1989 respectively. The range of average damage lies between 634.00 gm and 1022.92 gm. The average damage in different years is less significant in each of the study area. But the differences in damage in each of the study area are highly significant in the same year. Variance-ratio test (Table 17) also reveals the variation due to the replication years at each study site is insignificant ($F_{1,18}$=1.43,P=0.05), but there is a significant variation in damage at each place of the study in the same year ($F_{2,18}$=15.62, P=0.05). This variation is possibly due to two reasons. Firstly the number of individuals and the species depredating on crops are not similar at these places and secondly the intensity of birds' depredation is also not uniform everywhere in the study areas. The damage caused to the earhead of Sorghum by different bird species has been shown in Plate 1.

Damage assessment on Pearl millet by crows

The damage by crows to Pearl millet in two consecutive years (1988 and 1989) is between 147.61 gm and

Plate-1 Earhead of Sorghum damaged by different bird species.

Plate I

TABLE - 14 :- TOTAL DAMAGE TO SORGHUM (*Sorghum vulgare*) IN gm/100 EARHEADS IN DIFFERENT PLOTS AT UNIVERSITYFARM.

YEAR:1988

Categories	PLOT A			PLOT B			PLOT C			PLOT C		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	47	0	0	56	0	0	47	0	0	37	0
II	4.69	17	79.73	6.15	15	92.25	5.15	13	66.95	4.25	12	51.00
III	11.52	12	138.24	10.43	13	135.59	11.23	17	190.91	10.56	17	179.52
IV	17.81	9	160.29	18.21	7	127.47	19.15	12	229.80	16.29	11	179.19
V	20.41	11	224.51	21.46	6	128.76	22.21	6	133.26	18.75	18	337.50
VI	25.26	4	101.04	24.59	3	73.77	27.43	5	137.15	23.65	5	118.25
Overall damage:			703.81			557.84			758.07			865.46

YEAR:1989

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	46	0	0	49	0	0	35	0	0	36	0
II	5.12	14	71.68	4.15	18	81.00	4.18	15	62.70	4.12	18	74.16
III	10.41	11	114.51	9.52	13	123.76	8.65	17	147.05	9.18	15	137.70
IV	18.22	9	163.98	15.24	7	106.68	14.61	21	306.81	16.43	13	213.59
V	22.42	13	291.46	18.49	9	166.41	18.25	7	127.75	19.49	6	116.94
VI	26.23	7	183.61	24.26	4	97.04	25.21	5	126.05	25.22	12	302.64
Overall damage:			825.24			574.89			770.36			845.03

d = Wt. of grains damaged/earhead in each category.
n = No.of earheads damaged by visual estimation/100 sampled.
p = Total wt. of grains damaged in each category.

TABLE - 15 :- TOTAL DAMAGE TO SORGHUM (*Sorghum vulgare*) IN gm/100 EARHEADS IN DIFFERENT PLOTS AT BHAGWANGARHI.

YEAR:1988

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	57	0	0	48	0	0	45	0	0	48	0
II	5.18	13	67.34	4.69	15	70.35	4.52	17	76.84	4.29	15	64.35
III	10.36	19	196.84	11.15	19	211.85	9.85	19	187.15	11.19	11	123.09
IV	16.41	4	65.64	15.92	7	111.44	17.31	8	138.48	18.26	9	164.34
V	19.00	2	38.00	18.59	5	92.95	21.24	6	127.44	22.29	12	267.48
VI	23.95	5	119.75	25.43	6	152.58	25.61	5	128.05	26.41	5	132.05
Overall damage:			487.57			639.17			657.96			751.31

YEAR:1989

Categories	PLOT A			PLOR B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	49	0	0	44	0	0	54	0	0	58	0
II	4.62	17	78.54	5.24	17	89.08	5.22	18	93.96	4.51	16	72.16
III	11.29	13	146.77	10.95	13	142.35	11.63	10	116.30	12.25	11	134.75
IV	19.36	9	174.24	17.43	7	122.01	18.54	5	92.70	18.63	7	130.41
V	21.15	8	169.20	22.14	11	243.54	21.93	7	153.51	22.64	4	90.56
VI	24.52	4	98.08	25.19	8	201.52	27.41	6	164.46	25.81	4	103.24
Overall damage:			666.83			798.50			620.93			531.12

d = Wt. of grains damaged/earhead in each category.
n = No.of earheads damaged by visual estimation/100 sampled.
p = Total wt. of grains damaged in each category.

TABLE - 16 :- TOTAL DAMAGE TO SORGHUM (Sorghum vulgare) IN gm/100 EARHEADS IN DIFFERENT PLOTS AT CHHERAT.

YEAR:1988

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	39	0	0	32	0	0	46	0	0	50	0
II	5.24	15	78.60	5.11	13	66.43	6.29	18	113.22	8.23	15	123.45
III	11.21	12	134.52	9.63	19	182.97	13.45	13	174.85	12.69	12	152.28
IV	16.41	9	147.69	17.48	17	297.16	18.91	8	151.28	19.51	11	214.61
V	20.18	17	343.06	21.43	8	171.44	25.22	6	151.32	24.59	5	122.95
VI	26.45	8	211.60	26.89	11	295.79	29.15	9	262.35	31.22	7	218.54
Overall damage:			915.47			1013.79			853.02			831.83

YEAR:1989

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	35	0	0	37	0	0	34	0	0	44	0
II	6.49	15	97.35	6.82	13	88.66	5.89	15	88.35	6.12	18	110.16
III	14.51	18	261.18	15.53	15	232.95	13.28	24	318.72	15.17	15	227.55
IV	17.24	13	224.12	18.61	17	316.37	17.41	12	208.92	16.45	11	180.95
V	24.29	7	170.03	23.56	5	117.80	22.98	8	183.84	23.18	7	162.26
VI	30.35	12	364.20	29.18	13	379.34	30.45	7	213.15	29.16	5	145.80
Overall damage:			1116.88			1135.12			1012.98			826.72

d = Wt. of grains damaged/earhead in each category.
n = No.of earheads damaged by visual estimation/100 sampled.
p = Total wt. of grains damaged in each category.

TABLE - 17 ANALYSIS OF VARIANCE - ANOVA FOR THE INVESTIGATION OF VARIANCES IN THE EXTENT OF DAMAGE TO SORGHUM BY DIFFERENT BIRD SPECIES.

	Farms			
Years	Universityfarm	Bhagwangarhi	chherat	Total
1988	2885.18	2536.01	3614.11	9035.3
1989	3015.52	2617.38	4091.7	9724.6
Total	5900.7	5153.39	7705.81	18759.9

G = 18759.9 N = 24

C.F= G^2/N = 14663910.33

TSS of the table:

1988	8324263.63	6431346.72	13061791.09	27817401.44
1989	9093360.87	6850678.06	16742008.89	32686047.82
Total				60503449.26

TSS of the table = 461951.98
Replication SS(year) = 19797.27
Treatment SS (Farm) = 430489.25
(Replication x Treatment)SS = 11665.46
TSS of entire data = 709864.97

ANALYSIS OF VARIANCE TABLE

Source of variation (SV)	Degree of freedom (df)	Sum of square (SS)	Mean sum of square (MSS)	Variance-ratio (F)
Replication (years)	1	19797.27	19797.27	1.43
Treatment (Farms)	2	430489.25	215244.62	15.62
Replication x Treatment	2	11665.46	5832.73	
Error	18	247912.99	13772.94	
Total	23	709864.97		

Results: $F_{1,18}$= 1.43, P = 0.05

$F_{2,18}$= 15.62, P =0.05

411.06 gm per 100 earheads respectively. The damage to this crop is maximum in Chherat (Table 18 and Fig.4). A significant variation in the damage ratio was also recorded among all areas selected for the study of this crop. This variation is inescapable in both the years of study (Table 19,20 and 21). Statistical analysis of variance-ratio test (Table 22) also indicate a significant relationship in the ratio of damage due to replication years ($F_{1,18}$=11.9, P=0.05) as well as due to different agricultural farms studied in ($F_{2,18}$=9.46, P=0.05). The reason of this variation in damage is the varying number of crows depredating this crop in different years (Table 23). The variation in different places in the number of crows depredating a particular crop also suggest their unevenness in distribution while they search for their food.

Damage assessment on Pearl millet by different bird species

As table 18 and Fig.4 show, the damage in two years i.e. 1988 and 1989 ranged between 690.92 gm and 1424.25 gm. per 100 earheads respectively. The average damage is between 828.02 gm. and 1295.44 gm. The damage to this crop varies significantly in both the years. The overall damage to this crop in each plot of the study areas also differ very significantly (Tables 24,25 and 26). F - test of variation (Table 27) also proves a significant relationship

TABLE - 18 :- TOTAL DAMAGE OF PEARLMILLET (Pennisetum typhoides) IN gm/100 EARHEADS IN EACH PLOT AT DIFFERENT AGRICULTURAL FARMS.

DAMAGE BY CROWS

PLOTS	AGRICULTURAL FARMS					
	UNIVERSITYFARM		BHAGWANGARHI		CHHERAT	
	1988	1989	1988	1989	1988	1989
A	147.61	191.41	287.38	290.59	271.54	342.68
B	223.62	246.90	249.91	323.27	278.28	362.87
C	243.19	193.75	255.46	384.28	244.68	303.06
D	289.58	225.30	160.84	385.93	272.02	411.06
$\bar{X}$	226.00	214.34	238.34	346.01	266.63	354.91
S.E.	±25.60	±11.53	±23.50	±20.38	±6.47	±19.45

DAMAGE BY DIFFERENT BIRD SPECIES

PLOTS	AGRICULTURAL FARMS					
	UNIVERSITYFARM		BHAGWANGARHI		CHHERAT	
	1988	1989	1988	1989	1988	1989
A	690.92	801.20	1138.19	1068.93	1067.57	1217.25
B	720.30	899.60	956.17	1189.75	1150.36	1324.40
C	856.01	699.25	907.05	1330.24	973.34	1215.89
D	1044.86	851.89	659.94	1274.88	1017.71	1424.25
$\bar{X}$	828.02	812.98	915.33	1215.95	1052.24	1295.44
S.E.	±69.91	±37.15	±85.37	±49.26	±32.86	±43.20

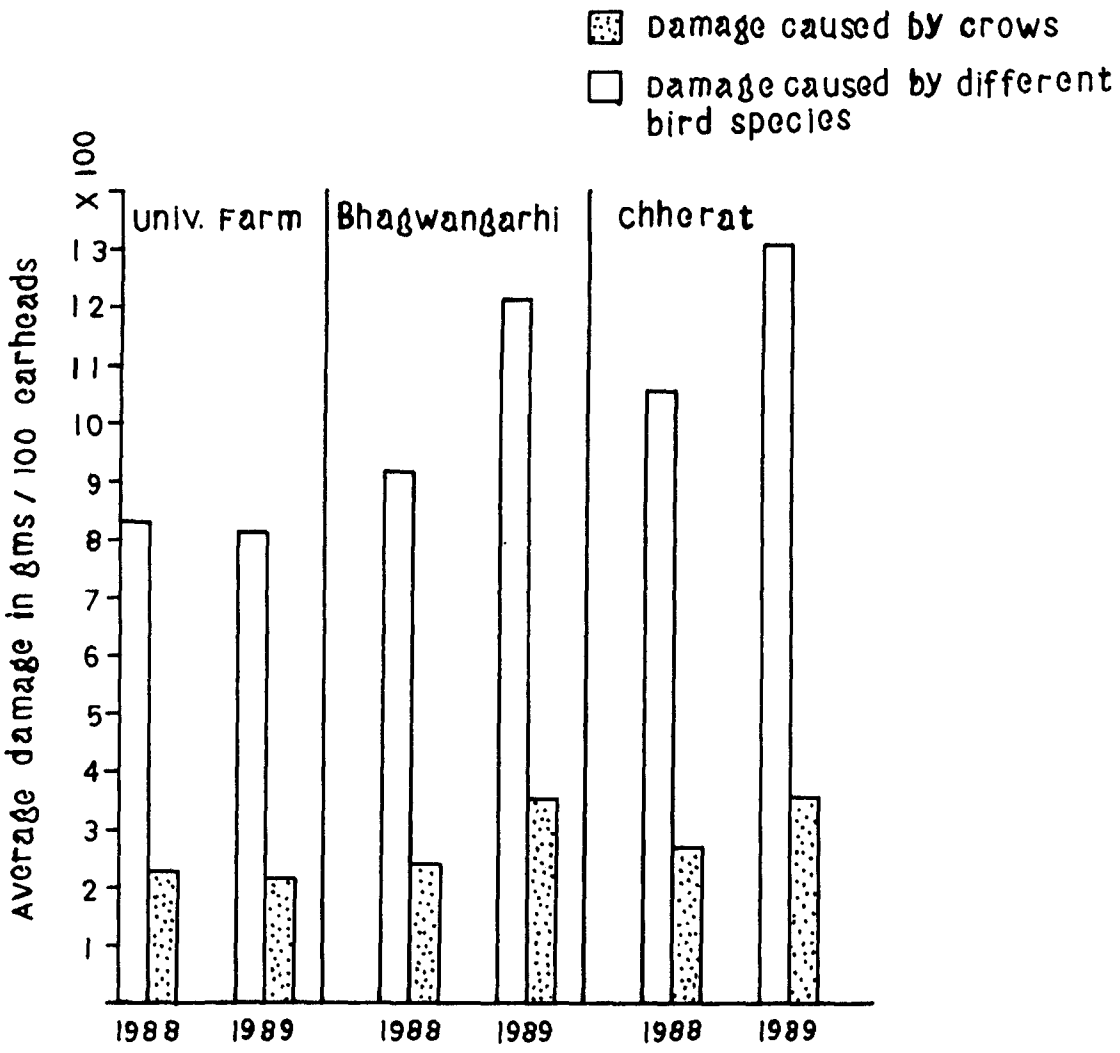


FIG. 4 AVERAGE DAMAGE OF PEARL MILLET IN gms/100 EARHEADS IN DIFFERENT AGRICULTURAL FARMS DURING 1988 AND 1989

TABLE - 19 :- SHARE OF DAMAGE BY HOUSE CORWS IN THE TOTAL LOSS OF PEARLMILLET (Pennisetum typhoides) IN gm/100 EARHEADS IN DIFFERENT PLOTS AT UNIVERSITYFARM

YEAR:1988

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	62	0	0	56	0	0	48	0	0	49	0
II	0.6648	8	5.31	1.038	8	8.304	1.18	14	16.52	1.67	11	18.37
III	1.9982	15	29.94	4.102	17	69.73	3.69	12	44.28	4.22	15	63.30
IV	3.7706	7	26.39	6.283	11	69.11	5.29	17	89.93	6.14	12	73.68
V	9.1584	4	36.63	9.564	5	47.82	9.18	5	45.90	8.15	6	48.90
VI	12.3352	4	49.34	12.318	3	36.95	11.64	4	46.56	12.19	7	85.33
Overall damage:			147.61			223.62			243.19			289.58

YEAR:1989

	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	56	0	0	57	0	0	66	0	0	61	0
II	1.12	15	16.80	1.54	12	18.48	1.23	10	12.30	1.62	7	11.34
III	2.98	8	23.84	3.29	9	29.61	2.97	7	20.79	2.86	12	34.32
IV	5.29	11	58.19	6.18	6	37.08	6.62	6	39.72	5.91	8	47.28
V	8.13	7	56.91	8.78	11	96.58	10.30	7	72.10	9.61	6	57.66
VI	11.89	3	35.67	13.03	5	65.15	12.21	4	48.84	12.45	6	74.70
Overall damage:			191.41			246.90			193.75			225.30

d = Wt. of grains damaged/earhead in each category.
n = No.of earheads damaged by visual estimation/100 sampled.
p = Total wt. of grains damaged in each category.

TABLE - 20 :- SHARE OF DAMAGE BY HOUSE CROWS IN THE TOTAL LOSS OF PEARLMILLET (*Pennisetum typhoides*) IN gm/100 EARHEADS IN DIFFERENT PLOTS AT BHAGWANGARHI.

YEAR:1988

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	41	0	0	51	0	0	55	0	0	68	0
II	1.25	17	21.25	1.17	15	17.55	1.66	13	21.58	1.45	11	15.95
III	3.62	13	47.06	4.14	12	49.68	3.28	7	22.96	3.91	10	39.10
IV	5.19	13	67.47	6.51	9	58.59	5.98	11	65.78	6.11	3	18.33
V	8.29	10	82.90	7.23	8	57.84	9.11	9	81.99	8.17	3	24.51
VI	11.45	6	68.70	13.25	5	66.25	12.63	5	63.15	12.59	5	62.59
Overall damage:			287.38			249.91			255.46			160.84

YEAR:1989

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	48	0	0	43	0	0	41	0	0	36	0
II	1.16	10	11.60	1.54	7	10.78	1.62	5	8.10	1.48	11	16.28
III	4.12	14	57.68	3.98	20	79.60	4.11	18	73.98	3.63	21	76.23
IV	6.21	14	86.94	5.75	13	74.75	6.01	16	96.16	6.51	13	84.63
V	7.98	9	71.82	6.98	10	69.80	9.23	12	110.76	9.17	7	64.19
VI	12.51	5	62.55	12.62	7	88.34	11.91	8	95.28	12.05	12	144.60
Overall damage:			290.59			323.27			384.28			385.93

d = Wt. of grains damaged/earhead in each category.
n = No.of earheads damaged by visual estimation/100 sampled.
p = Total wt. of grains damaged in each category.

TABLE - 21 :- SHARE OF DAMAGE BY HOUSE CROWS IN THE TOTAL LOSS OF PEARLMILLET (Pennisetum typhoides) IN gm/100 EARHEADS IN DIFFERENT PLOTS AT CHHERAT.

YEAR:1988

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	49	0	0	42	0	0	49	0	0	45	0
II	1.51	15	22.65	1.09	18	19.62	1.65	14	23.10	1.81	12	21.72
III	3.25	12	39.00	3.43	14	48.02	2.98	13	38.74	3.15	19	59.85
IV	6.21	10	62.10	5.91	12	70.92	4.73	11	52.03	5.69	12	68.28
V	9.61	9	86.49	8.62	7	60.34	8.93	9	80.37	8.51	7	59.57
VI	12.26	5	61.30	11.34	7	79.38	12.61	4	50.44	12.52	5	62.60
Overall damage:			271.54			278.28			244.68			272.02

YEAR:1989

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	41	0	0	36	0	0	39	0	0	38	0
II	1.95	15	29.25	1.14	11	12.54	1.09	18	19.62	1.73	10	17.30
III	4.09	14	57.26	3.93	24	94.32	4.18	12	50.16	4.62	18	83.16
IV	5.28	11	58.08	5.17	9	46.53	5.21	17	88.57	6.15	15	92.25
V	9.21	13	119.73	9.11	12	109.32	8.62	5	43.10	9.13	8	73.04
VI	13.06	6	78.36	12.52	8	100.16	11.29	9	101.61	13.21	11	145.31
Overall damage:			342.68			362.87			303.06			411.06

d = Wt. of grains damaged/earhead in each category.
n = No.of earheads damaged by visual estimation/100 sampled.
p = Total wt. of grains damaged in each category.

TABLE - 22 ANALYSIS OF VARIANCE - ANOVA FOR THE INVESTIGATION OF VARIANCES IN THE EXTENT OF DAMAGE TO PEARL MILLET BY CROWS.

	Farms			
Years	Universityfarm	Bhagwangarhi	Chherat	Total
1988	903.99	953.59	1066.52	2924.1
1989	857.36	1384.07	1419.67	3661.1
Total	1761.35	2337.66	2486.19	6585.2

G = 6585.2 N = 24

C.F= G^2/N = 1806869.1

TSS of table:

1988	817197.92	909333.89	1137464.9	2863996.71
1989	735066.17	1915649.8	2015462.9	4666178.8
Total				7530175.5

TSS of the table = 75674.78
Replication SS (year) = 22632.06
Treatment SS (Farm) = 36649.50
(Replication x Treatment)SS = 16393.22
TSS of entire data = 110507.55

ANALYSIS OF VARIANCE TABLE

Source of variation (SV)	Degree of freedom (df)	Sum of square (SS)	Mean sum of square (MSS)	Variance-ratio (F)
Replication (years)	1	22632.06	22632.06	11.69
Treatment (Farms)	2	36649.50	18324.75	9.46
Replication x Treatment	2	16393.22	8196.61	
Error	18	34832.78	1935.15	
Total	23	110507.55		

Results: $F_{1,18}$=11.07, P = 0.05
$F_{2,18}$=15.58, P = 0.05

TABLE - 23 :- NUMBER OF CROWS OBSERVED AROUND THE CROP FIELD OF PEARLMILLET AND THE NUMBEROF VISITANTS INFESTING THE CROP IN VARIOUS STAGES.

SPECIES AND POPULAR NAME	CORVUS SPLENDENS HOUSE CROW		CORVUS MACRORHYNCHOS JUNGLE CROW	
STAGES OF CROP DEVELOPMENT	1988	1989	1988	1989
Fruit setting	284/00*	395/00	55/00	73/00
Milky/Doughy	633/189	521/254	68/13	36/04
Ripening	695/216	482/321	45/09	98/16
Harvesting	576/231	744/342	72/15	66/07

* Upper figure in each column denotes the number of birds observed around the crop field and the lower figure indicates the number of bird visitants infesting the crop.

TABLE - 24 :- TOTAL DAMAGE TO PEARLMILLET (Pennisetum typhoides) IN gm/100 EARHEADS IN DIFFERENT PLOTS AT UNIVERSITYFARM.

YEAR:1988

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	57	0	0	55	0	0	45	0	0	42	0
II	5.54	11	60.94	6.92	9	62.28	6.41	16	102.56	8.09	14	113.26
III	11.09	15	166.35	11.72	17	199.24	10.39	13	135.07	12.07	19	229.33
IV	22.67	9	204.03	19.04	11	209.44	19.76	17	335.92	22.48	12	269.76
V	28.62	4	114.48	28.13	5	140.65	27.82	5	139.10	29.35	6	176.10
VI	36.28	4	145.12	36.23	3	108.69	35.84	4	143.36	36.63	7	256.41
Overall damage:			690.92			720.30			856.01			1044.86

YEAR:1989

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	52	0	0	52	0	0	58	0	0	50	0
II	6.95	18	125.10	7.56	14	105.84	5.63	14	78.82	6.54	16	104.64
III	12.43	9	111.87	13.45	11	147.95	11.08	11	121.88	11.77	13	153.01
IV	23.00	11	253.00	24.27	6	145.62	23..91	6	143.46	21.92	9	197.28
V	28.48	7	199.36	26.16	12	313.99	30.31	7	212.17	30.72	6	184.32
VI	37.29	3	111.87	37.24	5	186.20	35.73	4	142.92	35.44	6	212.64
Overall damage:			801.20			899.60			699.25			851.89

d = Wt. of grains damaged/earhead in each category.
n = No.of earheads damaged by visual estimation/100 sampled.
p = Total wt. of grains damaged in each category.

TABLE - 25 :- TOTAL DAMAGE TO PEARLMILLET (Pennisetum typhoides) IN gm/100 EARHEADS IN DIFFERENT PLOTS AT BHAGWANGARHI.

YEAR:1988

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	35	0	0	43	0	0	49	0	0	55	0
II	6.93	21	145.53	7.16	22	157.52	7.49	19	142.31	7.85	23	180.55
III	14.21	15	213.15	14.82	13	192.66	14.11	7	98.77	13.63	11	149.93
IV	21.41	13	278.33	22.28	9	200.52	19.97	11	219.67	19.21	3	57.63
V	28.86	10	288.60	28.29	8	226.32	28.10	9	252.90	28.11	3	84.33
VI	35.43	6	212.58	35.83	5	179.15	38.68	5	193.40	37.50	5	187.50
Overall damage:			1138.19			956.17			907.05			659.94

YEAR:1989

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	43	0	0	40	0	0	33	0	0	32	0
II	7.43	12	89.16	6.82	9	61.38	5.99	11	65.89	6.47	15	97.05
III	13.81	17	234.77	14.94	21	313.74	13.73	19	260.87	12.47	21	261.87
IV	20.92	14	292.88	21.92	13	284.96	22.39	16	358.24	20.59	13	267.67
V	30.33	9	272.97	27.20	10	272.00	26.83	12	321.96	28.79	7	201.53
VI	35.83	5	179.15	36.81	7	257.67	35.92	9	323.28	37.23	12	446.76
Overall damage:			1068.93			1189.75			1330.24			1274.88

d = Wt. of grains damaged/earhead in each category.
n = No. of earheads damaged by visual estimation/100 sampled.
p = Total wt. of grains damaged in each category.

TABLE - 26 :- TOTAL DAMAGE TO PERALMILLET (Pennisetum typhoides) IN gm/100 EARHEADS IN DIFFERENT PLOTS AT CHHERAT.

YEAR:1988

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	42	0	0	38	0	0	46	0	0	44	0
II	6.25	18	112.50	7.22	21	151.62	7.00	17	119.00	7.52	13	97.76
III	15.94	16	255.04	16.68	15	250.20	14.03	13	182.39	14.82	19	281.58
IV	24.03	10	240.30	23.40	12	280.80	24.84	11	273.24	22.71	12	272.52
V	31.37	9	282.33	29.24	7	204.68	28.35	9	255.15	27.75	7	194.25
VI	35.48	5	177.40	37.58	7	263.06	35.89	4	143.56	34.32	5	171.60
Overall damage:			1067.57			1150.36			973.34			1017.71

YEAR:1989

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	39	0	0	30	0	0	36	0	0	32	0
II	7.26	17	123.42	6.04	15	90.60	7.12	19	135.28	8.99	13	116.87
III	16.06	14	224.84	13.65	26	354.90	16.36	14	229.04	13.95	21	292.95
IV	23.33	11	256.63	22.62	9	203.58	21.69	17	368.73	25.25	15	378.75
V	30.54	13	397.02	31.39	12	376.68	29.59	5	147.95	29.85	8	238.80
VI	35.89	6	215.37	37.33	8	298.64	37.21	9	334.89	36.08	11	396.88
Overall damage:			1217.25			1324.40			1215.89			1424.25

d = Wt. of grains damaged/earhead in each category.
n = No. of earheads damaged by visual estimation/100 sampled..
p = Total wt. of grains damaged in each category.

TABLE - 27 ANALYSIS OF VARIANCE - ANOVA FOR THE INVESTIGATION OE VARIANCES IN THE EXTENT OF DAMAGE TO PEARL MILLET BY DIFFERENT BIRD SPECIES.

Years	Farms			Total
	Universityfarm	Bhagwangarhi	Chherat	
1988	3312.09	3661.35	4208.98	11182.42
1989	3251.94	4863.8	5181.79	13297.53
Total	6564.03	8525.15	9390.77	24479.95

G = 24479.95 N = 24

$C.F = \frac{G^2}{N}$ = 24969498

TSS of the table:

1988	10969940.16	13405483.8	17715512.64	42090936.62
1989	10575113.76	23656550.44	26850947.6	61082611.8
Total				103173548.4

TSS of the table = 823889.1
Replication SS(Year)= 186403.75
Treatment SS (Farm) = 524406.17
(Replication x Treatment)SS = 113079.18
TSS of entire data = 1126798.43

ANALYSIS OE VARIANCE TABLE

Source of variation (SV)	Degree of Freedom (df)	Sum ofsquare (SS)	Mean sum of square (MSS)	Variance-ratio (F)
Replication (years)	1	186403.75	186403.76	11.07
Treatment (Farms)	2	524406.17	262203.08	15.58
Replication x Treatment	2	113079.18	56539.59	
Error	18	302909.33	16828.29	
Total	23	1126798.43		

Results: $F_{1,18}$ = 11.07, P = 0.05
$F_{2,18}$ = 15.58, P = 0.05

in the variation of damage in replication years ($F_{1,18}$= 11.07, P=0.05) as well as in different agricultural farms ($F_{2_{18}}$=15.58, P=0.05). The possible reasons of these variations in the damage are varying number of depredatory bird species, the variation in their frequency of depredation and also varying degrees of farmer's attentivenes towards scaring these depredatory species from their farms.

During Oct., Nov. and early Dec. the birds were seen feeding on the grains of standing crops of sorghum and Pearl millet. Several species of birds inflict damage to the grains of the above mentioned crops. The most common among them are House sparrow, Baya weaver bird, Roseringed parakeet, House crow, Starling, Bank myna, Blossom headed parakeet and Large grey babbleer. Occasional visitors are the Common myna, Red munia and Rosefinch. Table 28 follows the list of birds and their description.

Bird community depredating Pearl millet comprised of 10 species where as that on the sorghum consisted of 12 species. House sparrows are the most abundant of all recorded species feeding on Pearl millet and sorghum. The next abundant species was Baya weaver bird on both the crops.

Birds were observed to perch on or near the earheads and remove the grains from the spikelet leaving behind the glumes intact. In case of sorghum sometimes the parts of the grains are left inside the glumes. Big birds like

TABLE - 28 BIRDS OBSERVED DEPREDATING ON MATURE SORGHUM AND PEARL MILLET IN INTENSIVE STUDY AREAS.

S.No.	Common and scientific names of depredatory species.	Damage on	
		Sorghum	Pearl millet
1.	Common myna (Acridotheres tristis)	X	✓
2.	Bank myna (Acridotheres ginginianus)	✓	✓
3.	House sparrow (Passer domesticus)	✓	✓
4.	Baya weaverbird (Ploceus phillipinus)	✓	✓
5.	Red munia (Estrilda amandava)	X	✓
6.	Spotted munia (Lonchura punctulata)	✓*	✓
7.	White throated munia (Lonchura malabarica)	✓*	X
8.	House crow (Corvus splendens)	✓	✓
9.	Jungle crow (Corvus macrorhynchos)	✓	✓**
10.	Roseringed parakeet (Psittacula krameri)	✓	✓
11.	Northern Blossom headed parakeet (Psittacula cyanocephala)	✓	X
12.	Large grey babbler (Turdoides malcomi)	✓	X
13.	Rosefinch (Caprodacus erythrinus)	✓*	X
14.	Starling (Sturnus vulgaris)	✓	✓

* Found feeding occasionally on that crop.

** Found feeding occasionally on both the crops.

Roseringed Parakeet sometimes clip off a part of earhead and take it to a nearby tree or some other perch for feeding on grains.

In case of sorghum crows were found removing not only the grains but clipping off a few (3 to 4) branches of the earhead with grains. In case of Pearl millet the crow perch on the basal portion of the spikelet and remove 4-5 grains together in one peck leaving a small gap in the earhead. The earheads of Pearl millet damaged by crows and other bird species has been shown in Plate 2 (a)& 2 (b).

Damage assessment on maize seedlings by crows

Control Plots

The total damage to the seedlings in two consecutive years (1988 and 1989) of the study ranged between 25.71% and 36.53%. This damage was recorded for 21 days and weekly variations were calculated (Table 29, Figs. 5 and 6). The maximum damage was recorded during the first week (ranged between 14.66% and 23.94%) while it decreased considerably during the second week (between 7.23% and 9.94%) and further to the negligible extent i.e. 1.4% by the end of the third week. The damage to the seedlings was more in the area situated near the roosting place of crows (Tables 30 and 31, Figs. 7 to 12).

It had been observed that the pigeons and the House

Plate-2 (a) Earheads of Pearl millet damaged by birds.

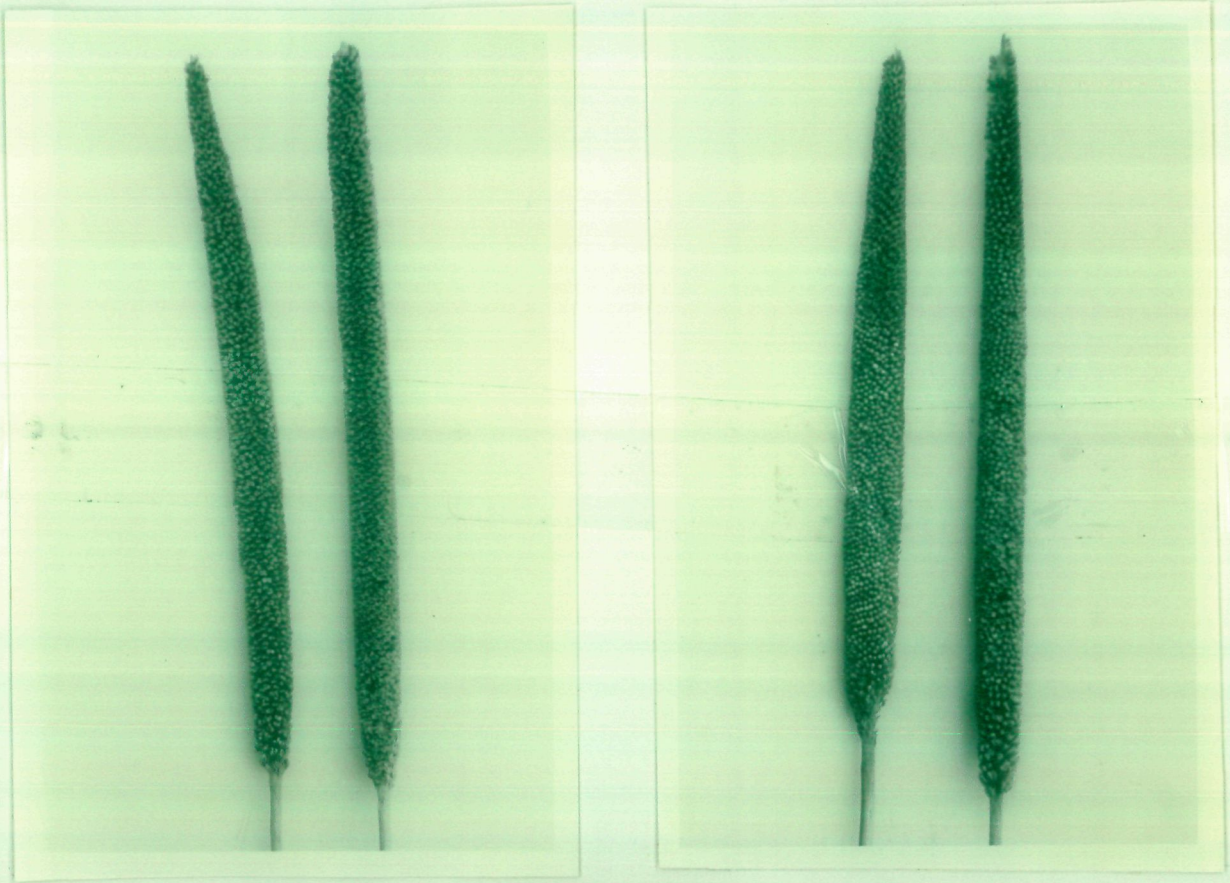


Plate 2(a)

Plate-2(b) Close-up of 2(a).

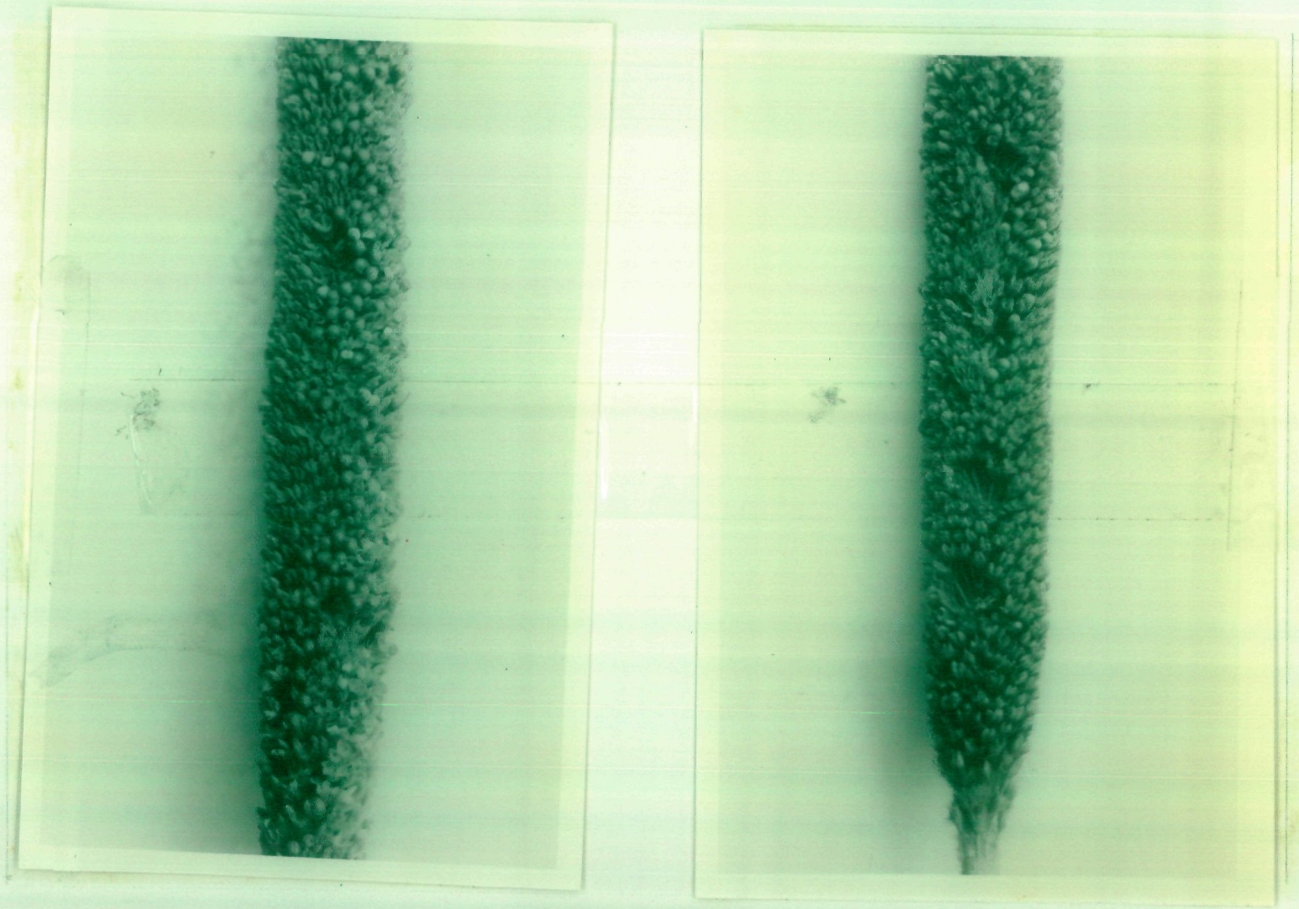


Plate 2(b)

crows were the first to invade the crop after sowing and cuase considerable damage at both; germination and seedling stages.

These pests pick the soaked seeds from the fields which were in the process of germination and fed on them. They also pluck out the developing seedlings. The number of Pigeons decreased significantly to about 10-15 initially after 3-4 days of the seed germination and later on it reduced to negligible extent. House crows continued depredation till 21 days of germination. In the first week number of crows were very high in the field. Significantly it decreased during the second week of germination and by the end of the third week it reduced to almost negligible. This gradual decrease of the crows in the field explains the gradual decrease in the damage of seedlings. This decrease in the number of crows can be related with the growth of seedlings and their low nutritive values in the end of third week which also compelled the crows to leave the site immediately.

Experimental Plots

The total damage to the seedlings recorded during three weeks of germination ranged between 0.43% and 3.36% in two consecutive years (1988 and 1989). The damage in the first week was 1.1% which increased to 2.06% in the

second week. Consequently it decreased to 1.4% during the third week (Table 29,Figs. 5 and 6). It was also observed that at certain places no damage was done at all during the first week of germination. A high damage was recorded in both the years in the field situated near the roosting place of the crows. (Tables 30 and 31,Figs.7 to 12).

It is important to mention that the ribbon had been very effective in the beginning but after a week time the crows became used to it and started feeding on the seedlings. They were most often seen in a party of 10-15 feeding on the seedlings but always found in the field for a very short duration and often in the morning from 6.00 to 6.30 hours initially. The time span then increased subsequently from 6.00 to 7.15 hours after one week. Sometimes they have also been observed in the evening from 18.00 to 19.00 hours. The increase in duration of the presence of crows and the inclusion of evenings as feeding hours explains higher damage to the seedlings in the second week. The damage in the last week of observation is 1.4%. This is less than the second week's damage. This could be because the number of crows damaging the seedlings decreased and it is possibly due to the size of seedlings and their low nutritive values at the end of second week.

Damage assessment on mature maize by crows

The damage caused by crows to mature maize during

TABLE - 29 :- DAMAGE (%) TO MAIZE SEEDLINGS BY HOUSE CROWS/WEEK AFTER GERMINATION.

YEAR		1988				1989			
AREA	WEEK	DAMAGE (%) QUADRAT NO. CONTROL 1	CONTROL 2	EXPERIMENTAL 1	EXPERIMENTAL 2	DAMAGE (%) QUADRAT NO. CONTROL 1	CONTROL 2	EXPERIMENTAL 1	EXPERIMENTAL 2
UF	Ist	19.61	18.83	0.13	0.08	18.65	18.39	0.07	0.55
	2nd	7.24	7.74	0.28	0.05	7.23	8.53	0.36	0.60
	3rd	1.95	2.47	0.04	0.24	1.23	1.57	0.00	0.04
	Total	28.80	29.04	0.45	0.82	27.11	28.49	0.43	1.19
BG	Ist	17.76	18.17	0.44	1.10	14.66	17.26	0.00	0.00
	2nd	9.56	8.45	0.48	0.36	7.79	8.86	0.34	0.63
	3rd	2.75	3.11	0.12	0.10	3.08	3.08	0.14	0.19
	Total:	30.07	29.73	1.04	1.56	25.71	29.20	0.49	0.82
CH	Ist	21.73	20.94	1.86	0.49	23.94	23.88	0.00	0.00
	2nd	8.97	9.94	0.85	1	9.50	8.96	2.06	1.96
	3rd	1.40	4.60	0.15	0.11	3.09	3.24	1.07	1.40
	Total:	32.10	35.48	2.86	1.60	36.53	36.08	3.13	3.36

UF = Universityfarm, BG = Bhagwangarhi, CH = Chherat
Control = Unprotected, Experimental = Protected.

TABLE - 30 DAILY DAMAGE (%) TO MAIZE SEEDLINGS BY HOUSE CROWS IN INTENSIVE STUDY AREAS (YEAR:1988)

DAYS	UNIVERSITYFARM TOTAL DAMAGE(%) QUADRAT NO.				BHAGWANGARHI TOTAL DAMAGE(%) QUADRAT NO.				CHHERAT TOTAL DAMAGE(%) QUADRAT NO.			
	CONTROL		EXPERIMENTAL		CONTROL		EXPERIMENTAL		CONTROL		EXPERIMENTAL	
	1	2	1	2	1	2	1	2	1	2	1	2
1.	4.27	4.32	0.00	0.00	3.79	4.12	0.00	0.00	4.29	3.87	0.00	0.00
2.	4.09	4.18	0.00	0.00	3.41	3.29	0.00	0.00	4.01	4.32	0.00	0.00
3.	3.07	3.23	0.00	0.00	3.56	2.78	0.00	0.00	3.76	2.91	0.00	0.00
4.	2.76	2.08	0.00	0.00	2.11	2.15	0.00	0.00	2.98	3.14	0.00	0.00
5.	2.13	1.97	0.00	0.00	1.93	2.71	0.11	0.17	3.23	2.77	0.53	0.00
6.	1.82	1.34	0.09	0.00	1.34	1.69	0.18	0.49	2.11	2.14	0.61	0.00
7.	1.47	1.71	0.04	0.08	1.62	1.43	0.15	0.44	1.35	1.79	0.72	0.49
8.	1.44	1.63	0.12	0.17	2.31	1.82	0.12	0.09	1.86	2.75	0.52	0.31
9.	1.12	1.24	0.09	0.13	1.48	1.29	0.11	0.07	1.92	1.61	0.15	0.17
10.	1.13	1.18	0.04	0.04	1.83	1.63	0.07	0.12	1.74	1.94	0.12	0.38
11.	0.98	1.29	0.03	0.07	1.07	1.13	0.04	0.05	1.06	1.03	0.04	0.09
12.	1.02	0.93	0.00	0.03	0.98	0.94	0.06	0.03	0.98	0.87	0.00	0.03
13.	0.84	0.78	0.00	0.06	0.87	0.79	0.08	0.00	0.82	0.98	0.02	0.00
14.	0.71	0.69	0.00	0.00	1.02	0.85	0.00	0.00	0.59	0.76	0.00	0.02
15.	0.61	0.54	0.00	0.00	0.91	0.64	0.12	0.00	0.48	0.83	0.00	0.05
16.	0.49	0.61	0.00	0.00	0.64	0.52	0.00	0.02	0.29	0.47	0.15	0.04
17.	0.28	0.42	0.04	0.00	0.41	0.71	0.00	0.03	0.34	0.52	0.00	0.00
18.	0.17	0.37	0.00	0.00	0.37	0.57	0.00	0.05	0.06	1.39	0.00	0.00
19.	0.19	0.21	0.00	0.11	0.21	0.36	0.00	0.00	0.07	0.26	0.00	0.00
20.	0.13	0.18	0.00	0.05	0.08	0.19	0.00	0.00	0.12	0.22	0.00	0.00
21.	0.08	0.14	0.00	0.08	0.13	0.12	0.00	0.00	0.04	0.15	0.00	0.00
Total	28.80	29.04	0.45	0.82	30.07	29.73	1.04	1.56	32.1	35.48	2.86	1.60

Control = Unprotected, Experimental = Protected.

TABLE - 31 DAILY DAMAGE (%) TO MAIZE SEEDLINGS BY HOUSE CROWS IN INTENSIVE STUDY AREAS (year:1989)

	UNIVERSITYFARM				BHAGWANGARHI				CHHERAT			
	TOTAL DAMAGE(%)				TOTAL DAMAGE(%)				TOTAL DAMAGE(%)			
DAYS	QUADRAT NO.				QUADRAT NO.				QUADRAT NO			
	CONTROL		EXPERIMENTAL		CONTROL		EXPERIMENTAL		CONTROL		EXPERIMENTAL	
	1	2	1	2	1	2	1	2	1	2	1	2
1.	5.61	4.84	0.00	0.00	3.14	3.98	0.00	0.00	5.01	4.83	0.00	0.00
2.	3.55	3.37	0.00	0.00	2.97	3.19	0.00	0.00	4.91	4.69	0.00	0.00
3.	2.44	2.29	0.00	0.00	2.15	2.73	0.00	0.00	3.98	3.37	0.00	0.00
4.	2.12	2.85	0.00	0.00	1.94	2.49	0.00	0.00	3.24	3.12	0.00	0.00
5.	1.89	2.12	0.00	0.00	1.62	1.78	0.00	0.00	2.73	2.98	0.00	0.00
6.	1.81	1.73	0.00	0.24	1.39	1.49	0.00	0.00	2.14	2.42	0.00	0.00
7.	1.23	1.19	0.07	0.31	1.45	1.61	0.00	0.00	1.93	2.47	0.00	0.00
8.	1.72	2.13	0.04	0.19	1.64	1.56	0.00	0.00	1.76	1.89	0.00	0.00
9.	1.54	1.89	0.21	0.18	1.37	1.48	0.00	0.00	1.59	1.74	0.00	0.00
10.	1.29	1.34	0.09	0.07	1.22	1.25	0.00	0.17	1.64	1.16	0.00	0.00
11.	0.79	1.11	0.02	0.08	0.86	1.91	0.13	0.12	1.48	1.21	0.00	0.00
12.	0.67	0.83	0.00	0.05	1.13	1.04	0.11	0.16	1.23	1.14	0.64	0.53
13.	0.93	0.78	0.00	0.03	0.93	0.88	0.04	0.13	0.89	0.97	0.69	0.61
14.	0.29	0.45	0.00	0.00	0.82	0.74	0.06	0.05	0.91	0.85	0.73	0.82
15.	0.26	0.49	0.00	0.00	0.91	0.59	0.09	0.08	0.83	0.76	0.86	0.91
16.	0.18	0.35	0.00	0.00	0.61	0.43	0.00	0.06	0.66	0.59	0.21	0.27
17.	0.23	0.31	0.00	0.00	0.45	0.51	0.05	0.03	0.47	0.64	0.00	0.18
18.	0.19	0.17	0.00	0.04	0.32	0.27	0.00	0.02	0.31	0.56	0.00	0.04
19.	0.17	0.08	0.00	0.00	0.29	0.22	0.00	0.00	0.35	0.48	0.00	0.00
20.	0.09	0.13	0.00	0.00	0.29	0.18	0.00	0.00	0.29	0.00	0.00	0.00
21.	0.11	0.04	0.00	0.00	0.21	0.14	0.00	0.00	0.18	0.21	0.00	0.00
Total	27.11	28.49	0.43	1.19	25.71	29.20	0.49	0.82	36.53	36.08	3.13	3.36

Control = Unprotected, Experimental = Protected

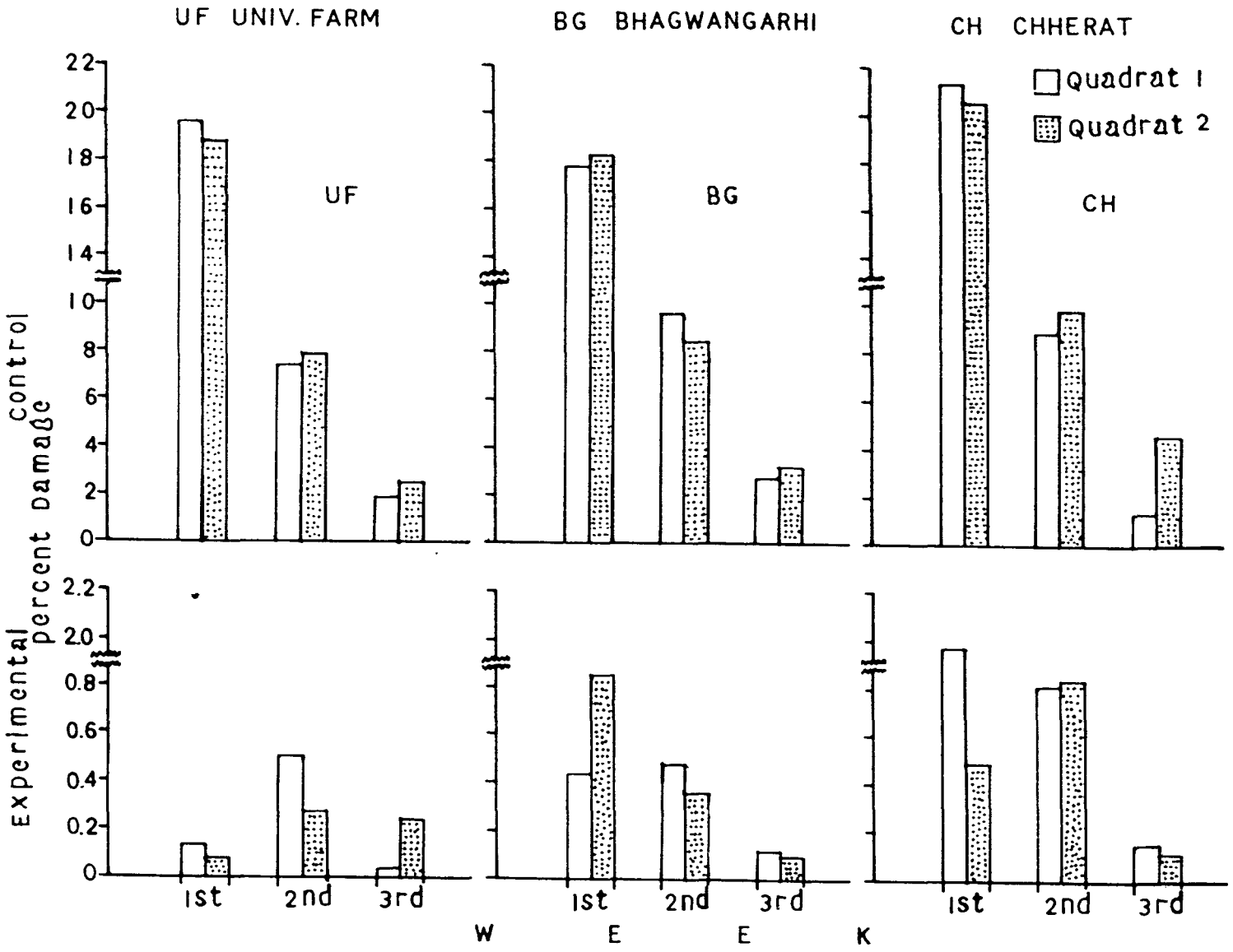


FIG. 5 DAMAGE (%) TO MAIZE SEEDLINGS BY HOUSE CROWS PER WEEK AFTER GERMINATION DURING 1988

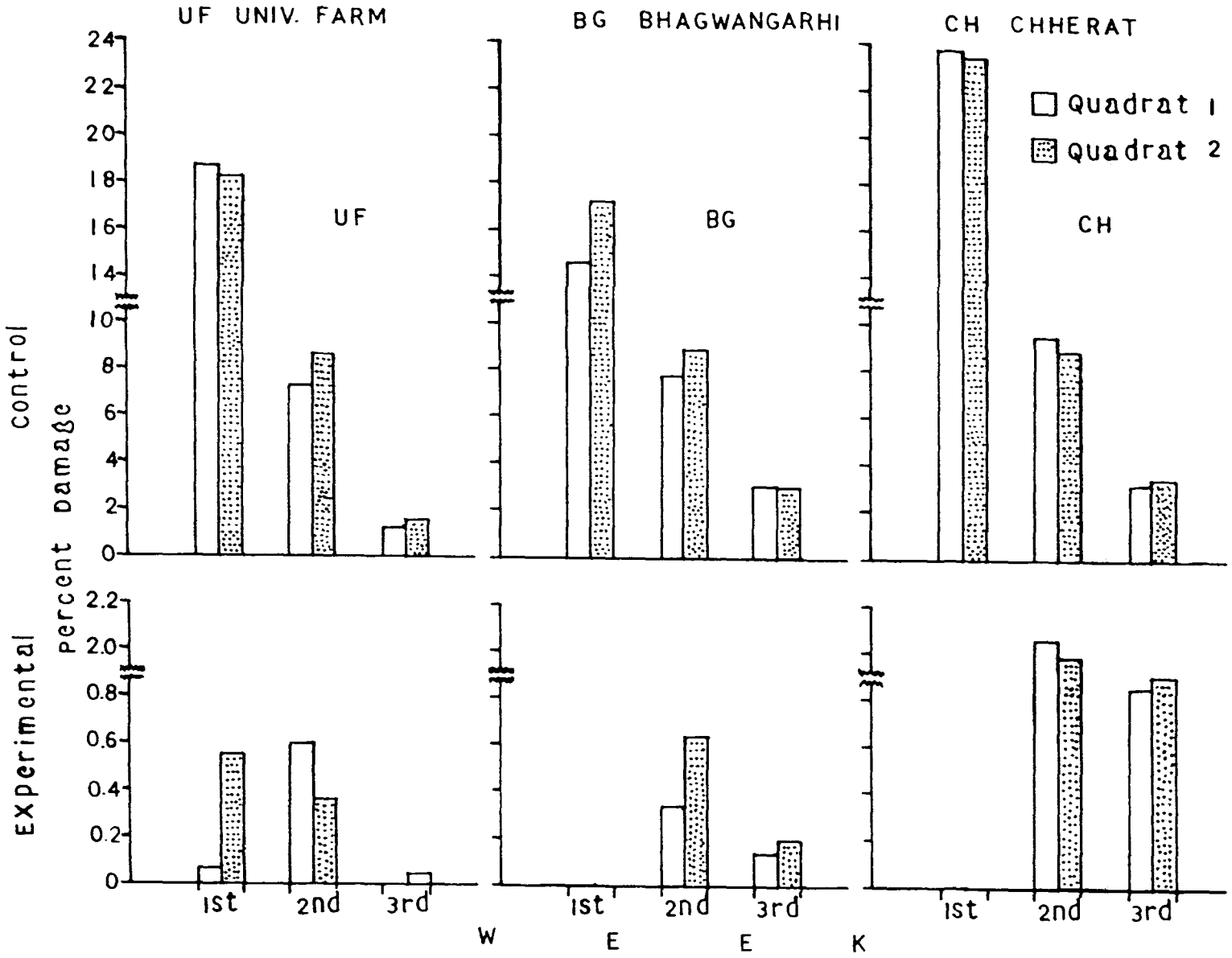


FIG. 6 DAMAGE (%) TO MAIZE SEEDLINGS BY HOUSE CROWS PER WEEK AFTER GERMINATION DURING 1989

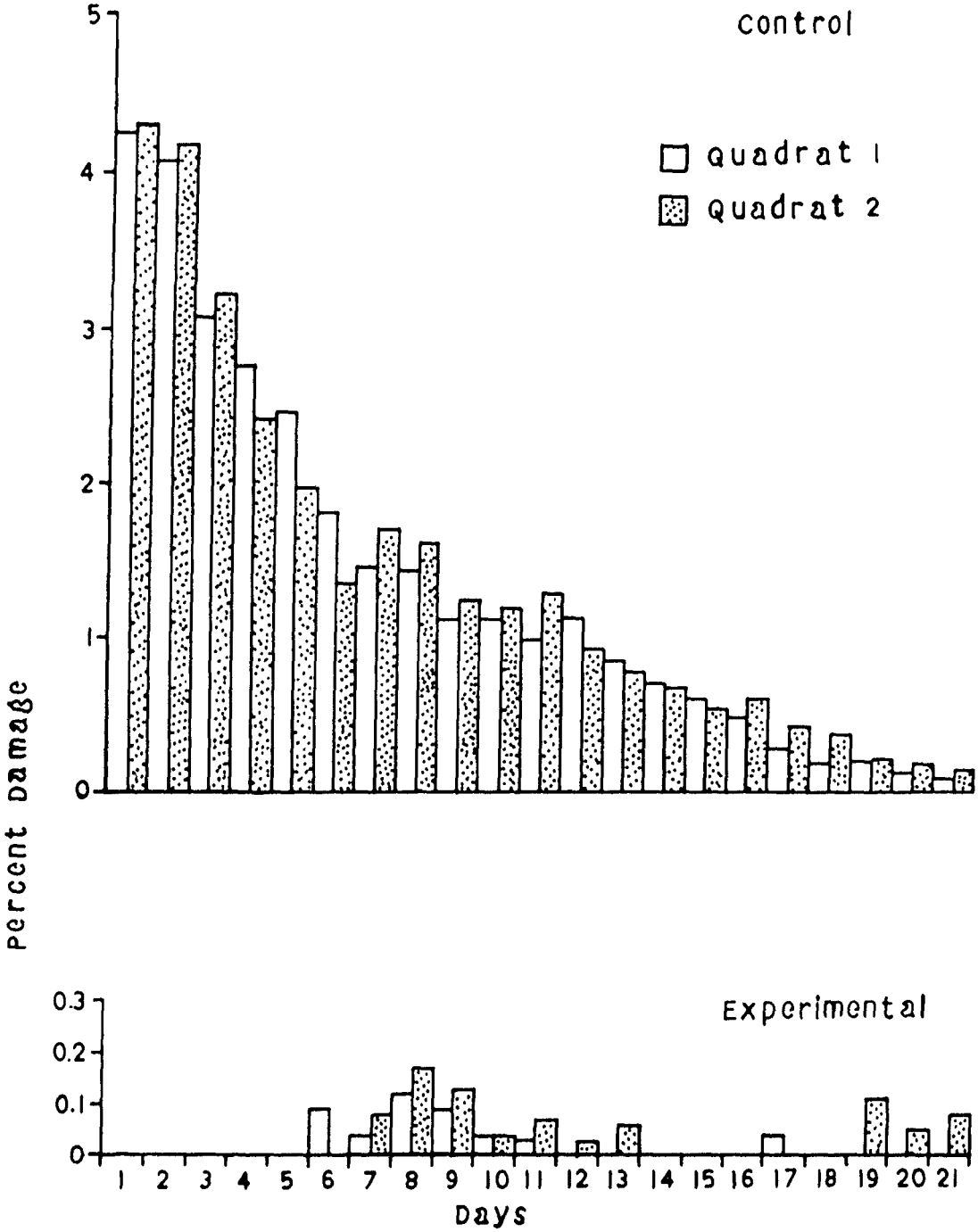


FIG. 7 DAILY DAMAGE % TO MAIZE SEEDLINGS BY HOUSE CROWS IN INTENSIVE STUDY AREA DURING 1988

AREA: UNIV. FARM

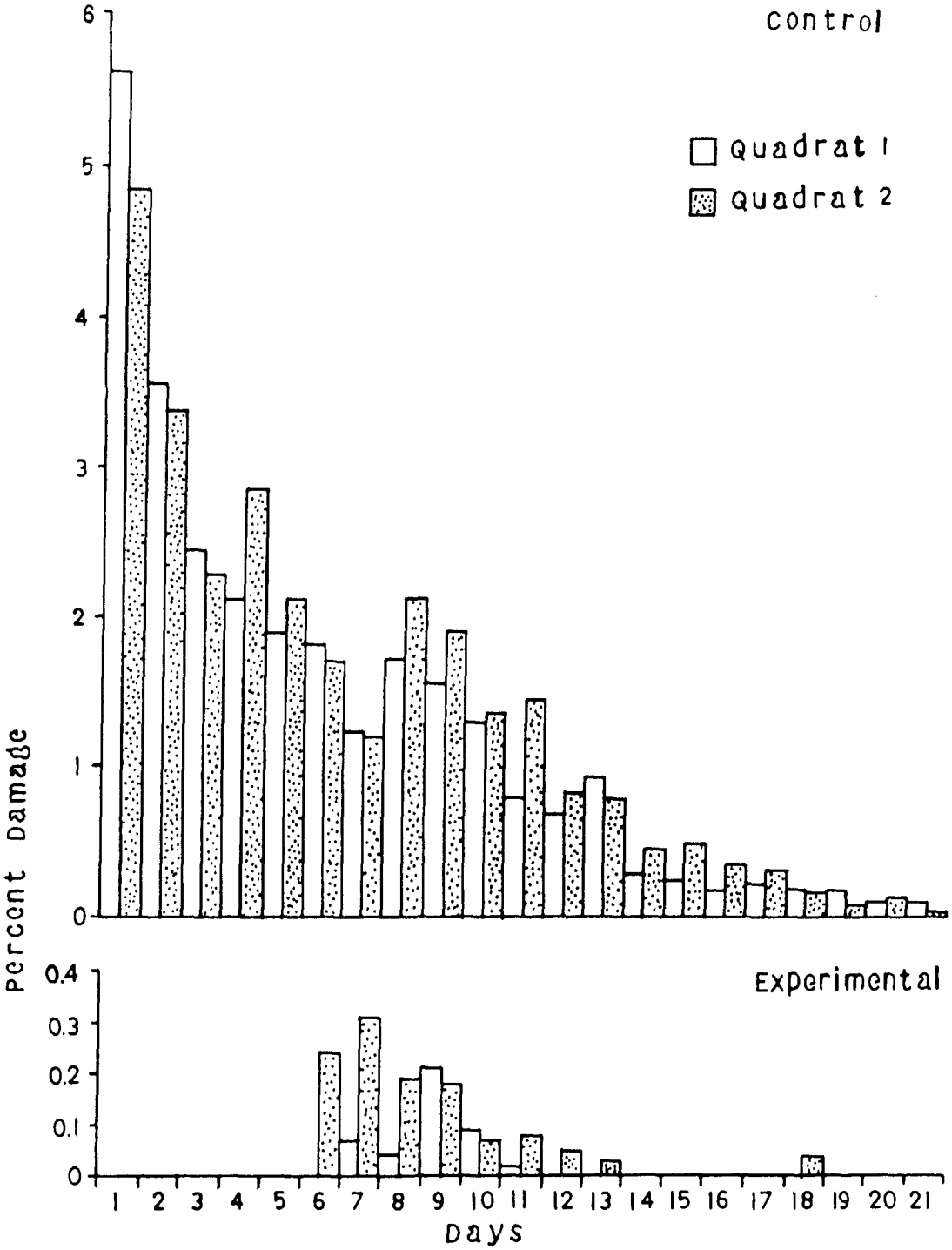


FIG. 8 DAILY DAMAGE % TO MAIZE SEEDLINGS BY HOUSE CROWS IN INTENSIVE STUDY AREA DURING 1989

AREA : UNIV. FARM

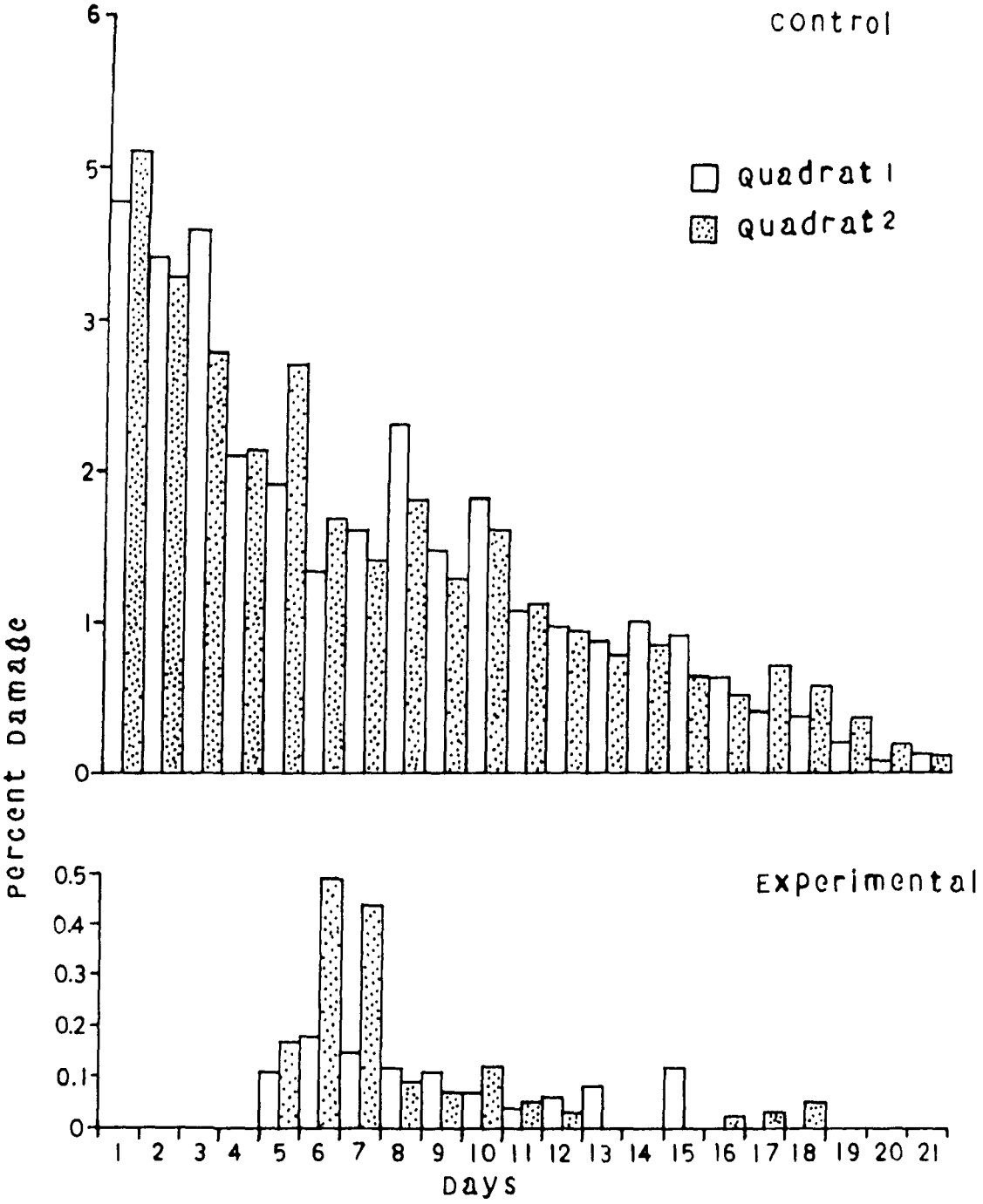


FIG. 9 DAILY DAMAGE (%) TO MAIZE SEEDLINGS BY HOUSE CROWS IN INTENSIVE STUDY AREA DURING 1988

AREA: BHAGWANGARHI

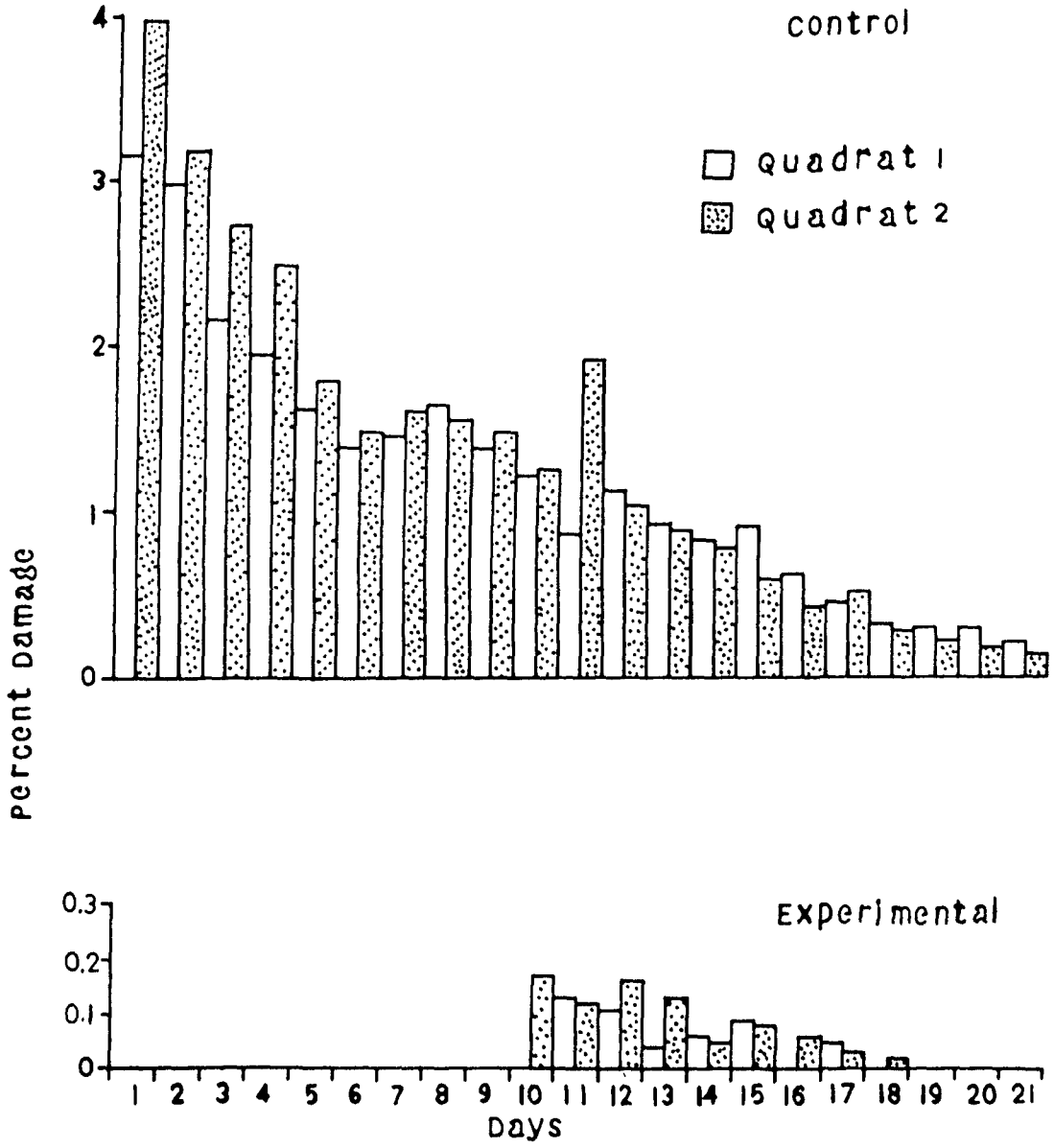


FIG.10 DAILY DAMAGE % TO MAIZE SEEDLINGS BY HOUSE CROWS IN INTENSIVE STUDY AREA DURING 1989

AREA: BHAGWANGARHI

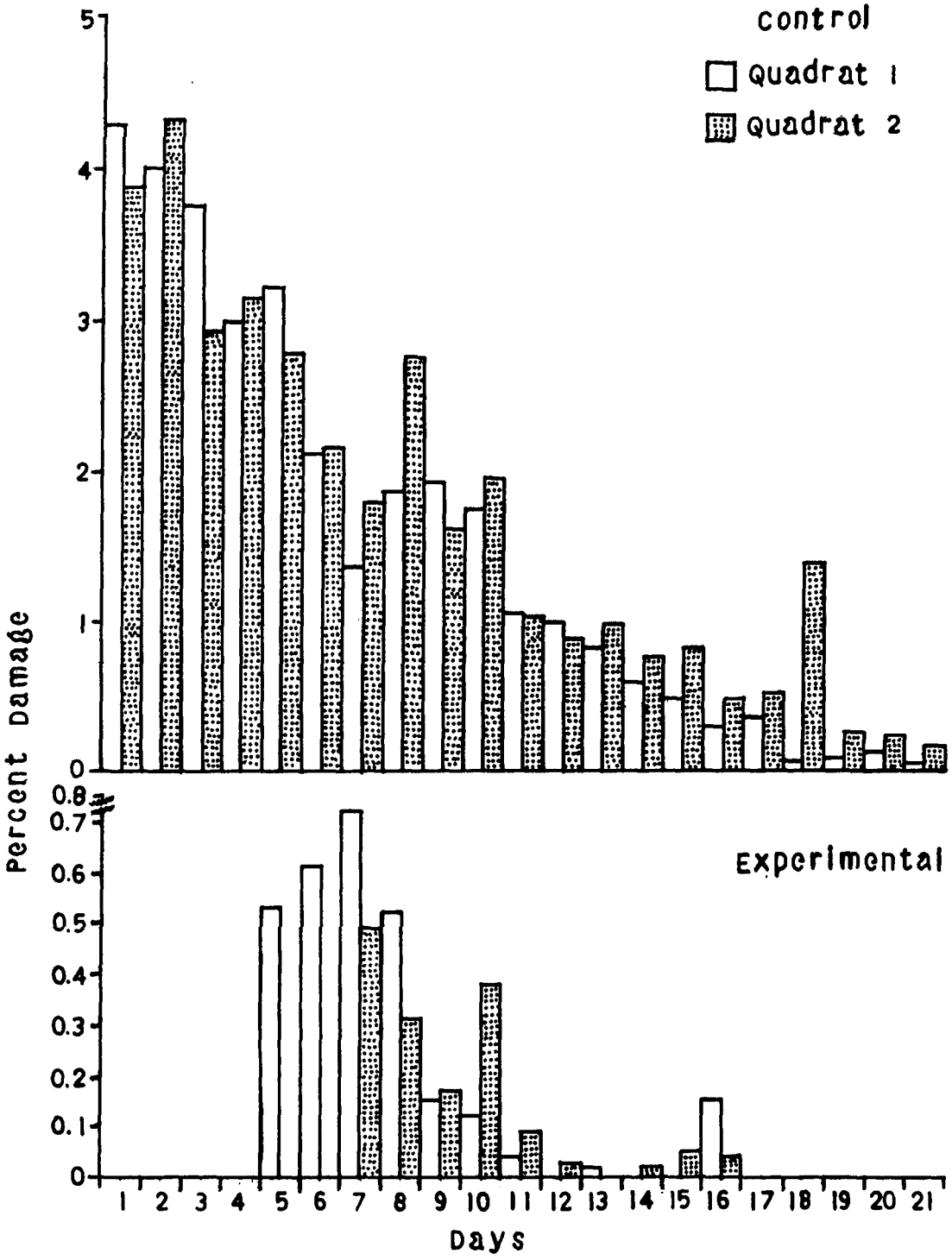


FIG. 11 DAILY DAMAGE (%) TO MAIZE SEEDLINGS BY HOUSE CROWS IN INTESIVE STUDY AREA DURING 1988

AREA: CHHERAT

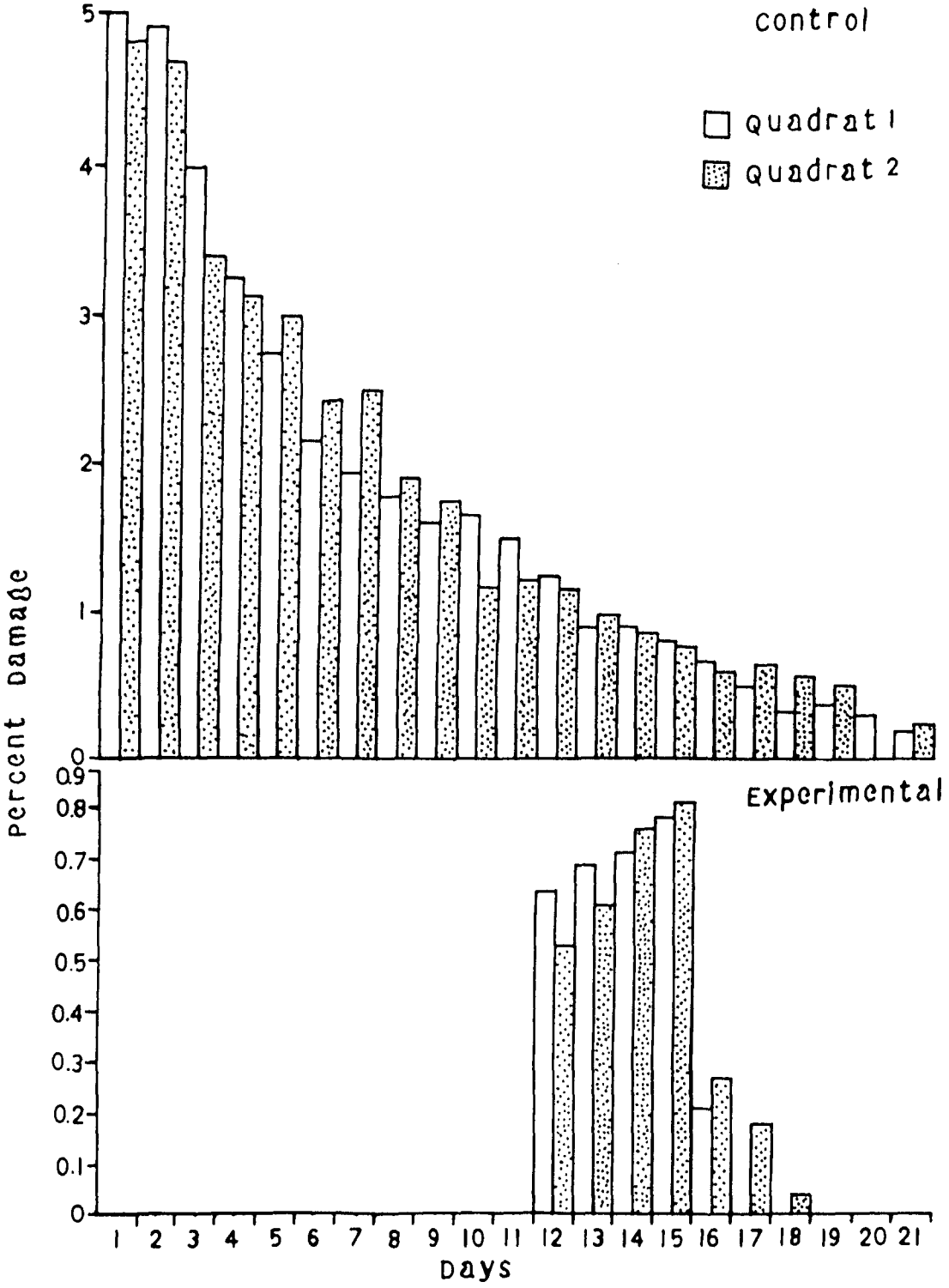


FIG.12 DAILY DAMAGE (%) TO MAIZE SEEDLINGS BY HOUSE CROWS IN INTENSIVE STUDY AREA DURING 1989 AREA: CHHERAT

1988 and 1989 at different study areas has been summarized in Table 32 and Fig.13. Maximum damage was recorded at Chherat, intermediate at Bhagwangarhi and minimum at Universityfarm in all the four plots during 1988. During 1989 again the maximum damage was recorded in Chherat but contrary to the previous year intermediate damage was recorded at Universityfarm and minimum at Bhagwangarhi (Table 33,34 and 35). The extent of damage caused by crows at different agricultural farms was statistically significant (F_{218}=16.68, P=0.05) but no significant variations were observed in the extent of damage in any of the study areas in replication years ($F_{1,18}$=0.86, P=0.05), (Table 36). The significant variation in damage at different agricultural farms is due to varying number of crows depredating this crop (Table 37) and dissimilarities in the frequency of crows visit to these places. The more damage in Chherat is due to the nearby crows roosting site.

Damage assessment on mature maize by different bird species.

The damage to this crop by different bird species is between 573.45 gm. and 1221.99gm. per 50 earheads. The average damage ranges between 653.11 gm. and 1109.24 gm. in the years 1988 and 1989 respectively. The extent of damage in different study areas thus significant in each plot but it is insignificant in each of the above mentioned years (Tables 32,38,39.40 and Fig.13).Statistically

the variation in damage was also insignificant in replication years ($F_{1,18}$=3.74, P=0.05) but it was significant in each of the agricultural farm ($F_{2,18}$=21.46, P=0.05), (Table 41). These variations in the damage at different farms are possibly due to unevenness in the distribution of depredatory crows and Parakeets at these places and the varying degrees of owner's attentiveness in scaring the depredatory species from their crop field. The more damage in Chherat is due to the roosting site of crows near the agricultural field.

Damage by crows start after the grains in the cob attain the dough stage. The crows prefer the cobs in which the damage is already initiated by Parakeets. In such cobs they completely remove the spathes, expose the cob and eat the grain. Crows damage a fresh healthy cob from the apical portion by pulling down the green spathes. During this process each green spathe is torn into small pieces to expose the grains fully.

Parakeets (Roseringed) infest the male inflorescence at flowering stage and feeds on the anthers and pollen-grains. They split and strip away the covering (bracts) thereby exposing the grains for easy feeding and further damage. This type of feeding is continued upto the maturity of the crop but the maximum damage was recorded at the dough stage of the cobs.

TABLE - 32 :- TOTAL DAMAGE OF MAIZE (Zea mays) IN gm/50 COBS IN EACH PLOT AT DIFFERENT AGRICULTURAL FARMS

DAMAGE BY CROWS

PLOTS	AGRICULTURAL FARMS					
	UNIVERSITYFARM		BHAGWANGARHI		CHHERAT	
	1988	1989	1988	1989	1988	1989
A	234.70	286.08	288.71	273.15	375.96	509.80
B	276.58	279.87	375.31	185.71	407.34	430.00
C	284.86	335.96	404.19	365.54	451.51	406.13
D	265.85	395.84	309.25	266.02	388.78	590.13
$\bar{X}$	265.49	324.43	344.36	272.60	405.89	484.01
S.E.	±9.50	±23.30	±23.54	±31.85	±14.30	±36.14

DAMAGE BY DIFFERENT BIRD SPECIES

PLOTS	AGRICULTURAL FARMS					
	UNIVERSITYFARM		BHAGWANGARHI		CHHERAT	
	1988	1989	1988	1989	1988	1989
A	573.45	697.59	717.66	598.25	899.96	1147.77
B	689.41	661.96	897.45	445.11	967.69	917.63
C	712.64	752.46	988.62	841.21	1116.97	1149.59
D	636.94	858.15	771.95	607.20	915.21	1221.99
$\bar{X}$	653.11	742.54	843.92	622.94	974.95	1109.24
S.E.	±26.77	±37.06	±52.98	±70 76	±42.87	±57.30

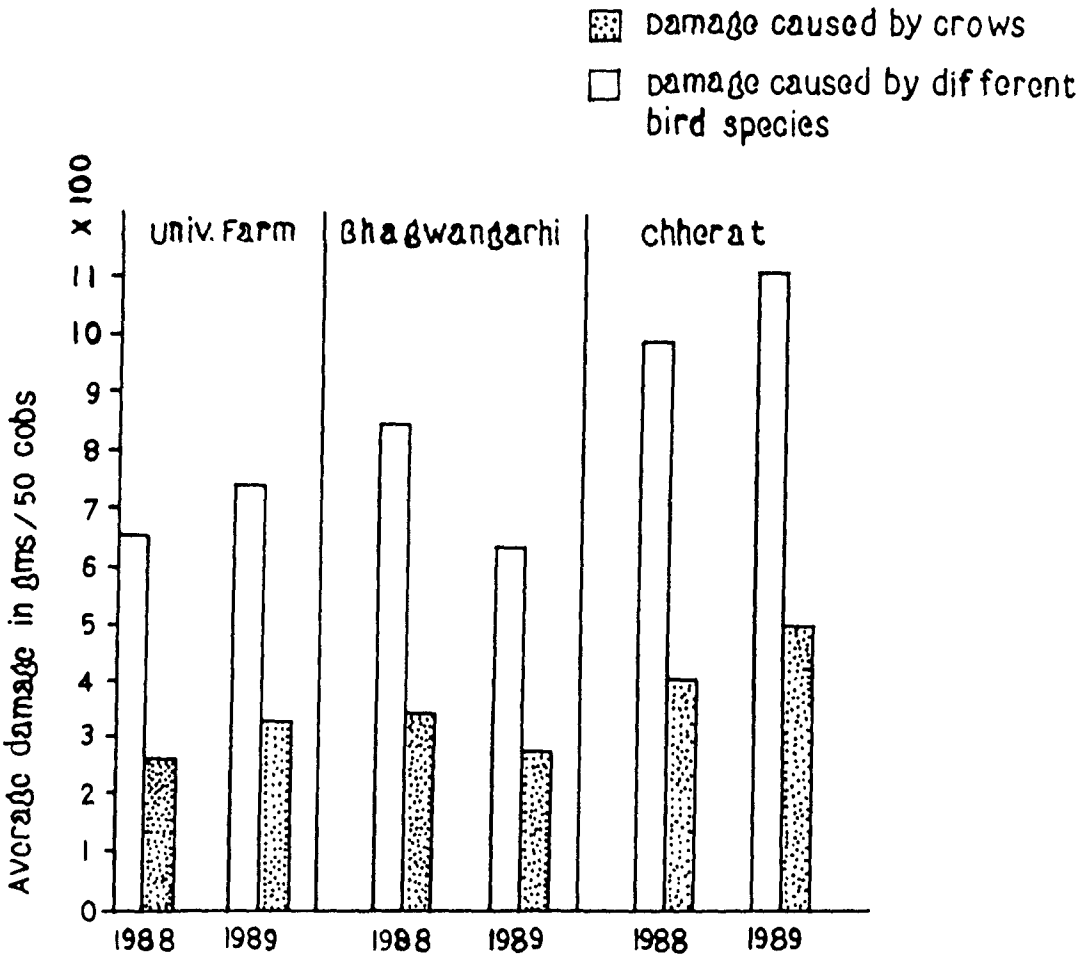


FIG.13 AVERAGE DAMAGE OF MAIZE IN gms/50 COBS IN DIFFERENT AGRICULTURAL FARMS DURING 1988 AND 1989

TABLE - 33 :- SHARE OF DAMAGE BY HOUSE CROWS IN THE TOTAL LOSS OF MAIZE,(Zea mays) IN gm/50 COBS IN DIFFERENT PLOTS AT UNIVERSITYFARM.

YEAR:1988

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	27	0	0	21	0	0	18	0	0	22	0
II	3.44	8	27.52	3.11	11	34.21	3.95	15	59.25	2.01	12	24.12
III	5.48	5	27.40	6.69	7	46.83	5.91	6	35.46	5.71	4	22.84
IV	13.68	4	54.72	13.44	5	67.20	11.93	5	59.65	11.70	5	58.50
V	18.59	4	74.36	19.04	4	76.16	17.74	3	53.22	18.97	3	56.91
VI	25.35	2	50.70	26.09	2	52.18	25.76	3	77.28	25.87	4	103.48
Overall damage:			234.70			276.58			284.86			265.85

YEAR:1989

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	18	0	0	27	0	0	20	0	0	14	0
II	2.77	16	44.32	3.01	7	21.07	3.45	9	31.05	3.71	11	40.81
III	6.13	3	18.39	6.25	4	25.00	6.87	6	41.22	6.05	5	30.25
IV	12.25	5	61.25	14.56	5	72.80	13.91	8	111.28	15.08	7	105.56
V	18.17	6	109.02	17.24	3	51.72	19.15	4	76.60	18.73	6	112.38
VI	26.55	2	53.10	27.32	4	109.28	25.27	3	75.81	26.71	4	106.84
Overall damage:			286.08			279.87			335.96			395.84

d = Wt. of grains damaged/earhead in each category
n = No.of earheads damaged by visual estimation/50 sampled.
p = Total wt. of grains damaged in each category.

TABLE - 34 :- SHARE OF DAMAGE BY HOUSE CROWS IN THE TOTAL LOSS OF MAIZE,(*Zea mays*) IN gm/50 COBS IN DIFFERENT PLOTS AT BHAGWANGARHI.

YEAR:1988

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	17	0	0	12	0	0	11	0	0	17	0
II	2.78	9	25.02	3.89	15	58.35	3.73	10	37.3	3.81	12	45.72
III	5.36	11	58.96	6.25	6	37.50	5.91	13	76.83	6.05	9	54.45
IV	11.93	7	83.51	12.43	9	111.87	11.84	5	59.20	12.25	5	61.25
V	18.14	4	72.56	18.71	5	93.55	17.61	6	105.66	16.91	4	67.64
VI	24.33	2	48.66	24.68	3	74.04	25.04	5	125.20	26.73	3	80.19
Overall damage:			288.71			375.31			404.19			309.25

YEAR:1989

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	28	0	0	33	0	0	16	0	0	25	0
II	4.05	4	16.20	3.78	3	11.34	4.27	8	34.16	3.71	9	33.39
III	7.85	7	54.95	6.98	5	34.90	6.75	12	81.00	5.98	6	35.88
IV	13.61	5	68.05	12.65	6	75.90	13.91	5	69.55	13.09	4	52.36
V	17.91	3	53.73	18.83	2	37.66	18.63	7	130.41	18.51	3	55.53
VI	26.74	3	80.22	25.91	1	25.91	25.21	2	50.42	29.62	3	88.86
Overall damage:			273.15			185.71			365.54			266.02

d= Wt. of grains damaged/earhead in each category.
n= No. of earheads damaged by visual estimation/50 sampled.
p= Total wt. of grains damage in each category.

TABLE - 35 :- SHARE OF DAMAGE BY HOUSE CROWS IN THE TOTAL LOSS OF MAIZE (Zea mays) IN gm/50 COBS IN DIFFERENT PLOTS AT CHHERAT.

YEAR:1988

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	14	0	0	14	0	0	4	0	0	15	0
II	2.39	10	23.9	3.71	7	25.97	4.71	18	84.78	3.89	8	30.8
III	6.44	12	77.28	6.83	15	102.45	7.22	13	93.86	6.29	12	75.48
IV	13.33	6	79.98	12.91	5	64.55	11.91	6	71.46	11.75	6	70.50
V	20.35	3	61.05	21.73	4	86.92	19.73	5	98.65	18.95	4	75.80
VI	26.75	5	133.75	25.49	5	127.45	25.69	4	102.76	27.24	5	136.20
Overall damage:			375.96			407.34			451.51			388.78

YEAR:1989

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	15	0	0	17	0	0	4	0	0	3	0
II	4.15	11	45.65	4.78	9	43.02	3.72	12	44.64	4.83	13	62.79
III	5.49	7	38.43	6.75	8	54.00	5.73	18	103.14	6.79	15	101.85
IV	12.91	9	116.19	13.84	6	83.04	12.98	9	116.82	15.81	7	110.67
V	19.65	5	98.25	20.62	4	82.48	18.43	5	92.15	22.65	6	135.90
VI	26.41	8	211.28	27.91	6	167.46	24.69	2	49.38	29.82	6	178.92
Overall damage:			509.80			430.00			406.13			590.13

d = Wt. of grains damaged/earhead in each category.
n = No. of earheads damaged by visual estimation/50 sampled.
p = Total wt. of grains damage in each category.

TABLE - 36 ANALYSIS OF VARIANCE - ANOVA FOR THE INVESTIGATION OF VARIANCES IN THE EXTENT OF DAMAGE TO MAIZE BY CROWS.

	Farms			
Years	Universityfarm	Bhagwangarhi	Chherat	Total
1988	1061.99	1377.46	1623.59	4063.04
1989	1297.75	1090.42	1936.06	4324.23
Total	2359.74	2467.88	3559.65	8387.27

G = 8387.27 N = 24

$C.F = G^2/N = 2931095.75$

TSS of the table:

1988	1127822.76	1897396.05	2636044.48	5661263.29
1989	1684155.06	1189015.77	3748328.32	6621499.17
Total				12282762.46

TSS of the table = 139594.86
Replication SS(year) = 2842.56
Treatment SS(Farm) = 110143.39
(Replication x Treatment)SS = 26608.91
TSS of entire data = 199009.18

ANALYSIS OF VARIANCE TABLE

Source of variation (SV)	Degree of freedom (df)	Sum of square (SS)	Mean sum of square (MSS)	Variance-ratio (F)
Replication (years)	1	2842.56	2842.56	0.86
Treatment (Farms)	2	110143.39	55071.69	16.68
Replication x Treatment	2	26608.91	13304.45	
Error	18	59414.31	3300.79	
Total	23	199009.18		

Results: $F_{1,18} = 0.86$, P = 0.05

$F_{2,18} = 16.68$, P = 0.05

TABLE - 37 :- NUMBER OF CROWS OBSERVED AROUND THE CROP FIELD OF MAIZE AND THE NUMBER OF VISITANTS INFESTING THE CROP IN VARIOUS STAGES.

SPECIES AND POPULAR NAME	CORVUS SPLENDENS HOUSE CROW		CORVUS MACRORHYNCHOS JUNGLE CROW	
STAGES OF CROP DEVELOPMENT	1987-88	1988-89	198-88	1988-89
Sowing	351/292*	456/318	51/16	29/11
Sprouting	411/358	429/351	82/19	66/24
Seedling	742/449	663/432	66/23	74/38
Sapling	314/00	428/00	95/00	81/00
Fruit setting	488/00	619/00	103/00	95/00
Milky/Doughy	417/213	512/305	45/08	69/15
Ripening	266/232	344/181	69/07	58/12
Harvesting	318/291	299/187	74/11	88/09

* Upper figure in each column denotes the number of birds observed around the crop field and the lower figure indicates the number of bird visitants infesting the crop.

TABLE - 38 :- TOTAL DAMAGE TO MAIZE (Zea mays) IN gm/50 COBS IN DIFFERENT PLOTS AT UNIVERSITYFARM.

YEAR:1988

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	27	0	0	21	0	0	18	0	0	22	0
II	10.14	8	81.12	9.15	11	100.65	11.63	15	174.45	6.29	12	75.48
III	15.23	5	76.15	18.59	7	130.13	16.91	6	101.46	15.45	4	61.80
IV	34.22	4	136.88	33.61	5	168.05	29.11	5	145.55	30.02	5	150.10
V	42.26	4	169.04	44.28	4	177.12	42.24	3	126.72	43.12	3	129.36
VI	55.13	2	110.26	56.73	2	113.46	54.82	3	164.46	55.05	4	220.20
Overall damage:			573.45			689.41			712.64			636.94

YEAR:1989

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	18	0	0		0	0	20	0	0	14	0
II	7.94	16	127.04	8.64	7	60.48	6.89	9	62.01	5.85	11	64.35
III	16.59	3	49.77	19.29	4	77.16	16.26	6	97.56	18.13	5	91.55
IV	29.22	5	146.10	33.46	5	167.30	30.45	8	243.60	32.61	7	228.27
V	43.61	6	261.66	44.98	3	134.49	45.21	4	180.84	42.91	6	257.46
VI	56.51	2	113.02	55.63	4	222.52	56.15	3	168.45	54.13	4	216.52
Overall damage:			697.59			661.96			752.46			858.15

d = Wt. of grains damaged/earhead in each category
n = No. of earheads damaged by visual estimation/50 sampled.
p = Total wt. of grains damage in each category.

TABLE - 39 :- TOTAL DAMAGE TO MAIZE (Zea mays) IN gm/50 COBS IN DIFFERENT PLOTS AT BHAGWANGARHI.

YEAR:1988

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	17	0	0	12	0	0	11	0	0	17	0
II	8.45	9	76.05	9.62	15	144.30	10.45	10	104.50	9.43	12	113.16
III	14.91	11	164.01	16.19	6	97.14	15.32	13	199.16	17.25	9	155.25
IV	28.42	7	198.94	31.41	9	282.69	29.61	5	148.05	33.21	5	166.05
V	43.21	4	172.84	42.15	5	210.75	44.51	6	267.06	43.76	4	175.04
VI	52.91	2	105.82	54.19	3	162.57	53.97	5	269.85	54.15	3	162.45
Overall damage:			717.66			897.45			988.62			771.95

YEAR:1989

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	o	28	0	0	33	0	0	16	0	0	25	0
II	11.26	4	45.04	10.43	3	31.29	7.42	8	59.36	8.22	9	73.98
III	15.23	7	106.61	16.49	5	82.45	14.22	12	170.64	16.19	6	97.14
IV	29.62	5	148.10	31.22	6	187.32	34.16	5	170.80	33.12	4	132.48
V	44.21	3	132.63	43.95	2	87.90	47.15	7	330.05	44.15	3	132.45
VI	55.29	3	165.87	56.15	1	56.15	55.18	2	110.36	57.05	3	171.15
Overall damage:			598.25			445.11			841.21			607.20

d = Wt. of grains damaged/earhead in each category.
n = No. of earheads damaged by visual estimation/50 samples.
p = Total wt. of grains damaged in each category.

TABLE - 40 :- TOTAL DAMAGE TO MAIZE (Zea mays) IN gm/50 COBS IN DIFFERENT PLOTS AT CHHERAT.

YEAR:1988

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	14	0	0	14	0	0	4	0	0	15	0
II	6.64	10	66.4	9.18	7	64.26	13.19	18	237.42	12.13	8	97.04
III	17.42	12	209.04	18.43	15	276.45	19.62	13	255.06	15.14	12	181.68
IV	34.19	6	205.14	33.18	5	165.90	31.82	6	190.92	29.62	6	177.72
V	46.21	3	138.63	47.62	4	190.48	42.61	5	213.05	43.28	4	173.12
VI	56.15	5	280.75	54.12	5	270.60	55.13	4	220.52	57.13	5	285.65
Overall damage:			899.96			967.69			1116.97			915.21

YEAR:1989

Categories	PLOT A			PLOT B			PLOT C			PLOT D		
	d	n	p	d	n	p	d	n	p	d	n	p
I	0	15	0	0	17	0	0	4	0	0	3	0
II	9.98	11	109.78	10.65	9	95.85	14.19	12	170.28	8.49	13	110.37
III	15.41	7	107.87	18.13	8	145.04	19.45	18	350.10	16.41	15	246.15
IV	28.61	9	257.49	31.18	6	187.08	33.62	9	302.58	35.91	7	251.37
V	44.59	5	222.95	41.19	4	164.76	43.25	5	216.25	46.17	6	277.02
VI	56.21	8	449.68	54.15	6	324.90	55.19	2	110.38	56.18	6	337.08
Overall damage:			1147.77			917.63			1149.59			121.99

d = Wt. of grains damaged/earhead in each category.
n = No. of earheads damaged by visual estimation/50 sampled.
p = Total wt. of grains damaged in each category.

TABLE - 41 ANALYSIS OF VARIANCE - ANOVA FOR THE INVESTIGATION OF VARIANCES IN THE EXTENT OF DAMAGE TO MAIZE BY DIFFERENT BIRD SPECIES.

	Farms			
Years	Universityfarm	Bhagwangarhi	Chherat	Total
1988	2612.44	3375.68	3899.83	9887.95
1989	2970.16	2491.77	4436.98	9898.91
Total	5582.6	5867.45	8336.81	19786.86

G = 19786.86 N = 24

C.F = G^2/N = 16313326.19

TSS of the table:

1988	6824842.8	11395215.46	15208674.02	33428732.28
1989	8821850.4	6208917.73	19686791.52	34717559.65
Total				68146291.93

TSS of the table = 723246.79
Replication SS(year) = 5
Treatment SS(Farm) = 573522.96
(Replication x Treatment)SS = 149718.83
TSS of entire data = 963695.03

ANALYSIS OF VARIANCE TABLE

Source of variation (SV)	Degree of freedom (df)	Sum of square (SS)	Mean sum of square (MSS)	Variance-ratio (F)
Replication (years)	1	5	5	3.74^{-04}
Treatment (farms)	2	573522.96	286761.48	21.46
Replication x Treatment	2	149718.83	74859.41	
Error	18	240448.24	13358.23	
Total	23	963695.03		

Results: $F_{1,18}$ = 3.74, P = 0.05

$F_{2,18}$ = 21.46, P = 0.05

Common myna occasionally visited the crop but only in small numbers. They were very occasionally found eating a few maize grains. Probably they visit to pick the insects. M.H.Ali et.al. (1982). The cobs of maize damaged by House crows and Parakeets have been shown in Plate 3 (a) & 3 (b).

Damage assessment on wheat seedlings by crows.

Control plots

From the table 42, Figs. 14 and 15 it is evident that the total damage to the seedlings by House crows in two consecutive years (1987 and 1988) ranges between 18.7% and 27.71%. In both the years the maximum damage was recorded during first week of germination (between 12.63% and 18.11%) while it decreased significantly during the second week (between 4.8% and 7.68%) and by the end of the third week it reduced to almost negligible extent i.e. 0.90%. The damage to the seedlings was recorded daily (Tables 43 and 44, Figs. 16 to 21) and found more in the study area situated near the roosting place of the crows.

It was observed that the Blue-rock piegeon, Ringdove, and the House crows are the first to invade the crop after sowing. Ringdove stopped depredating it after 5-6 days of sowing. Blue-rock pigeon and House crows cause damage at both; germination and seedling stages. The number of Blue-rock pigeon also reduced to negligible extent after 6-7 days of germination. The crows were noticed depredating

Plate-3(a) Cobs of maize damaged by House crows and Parakeets.

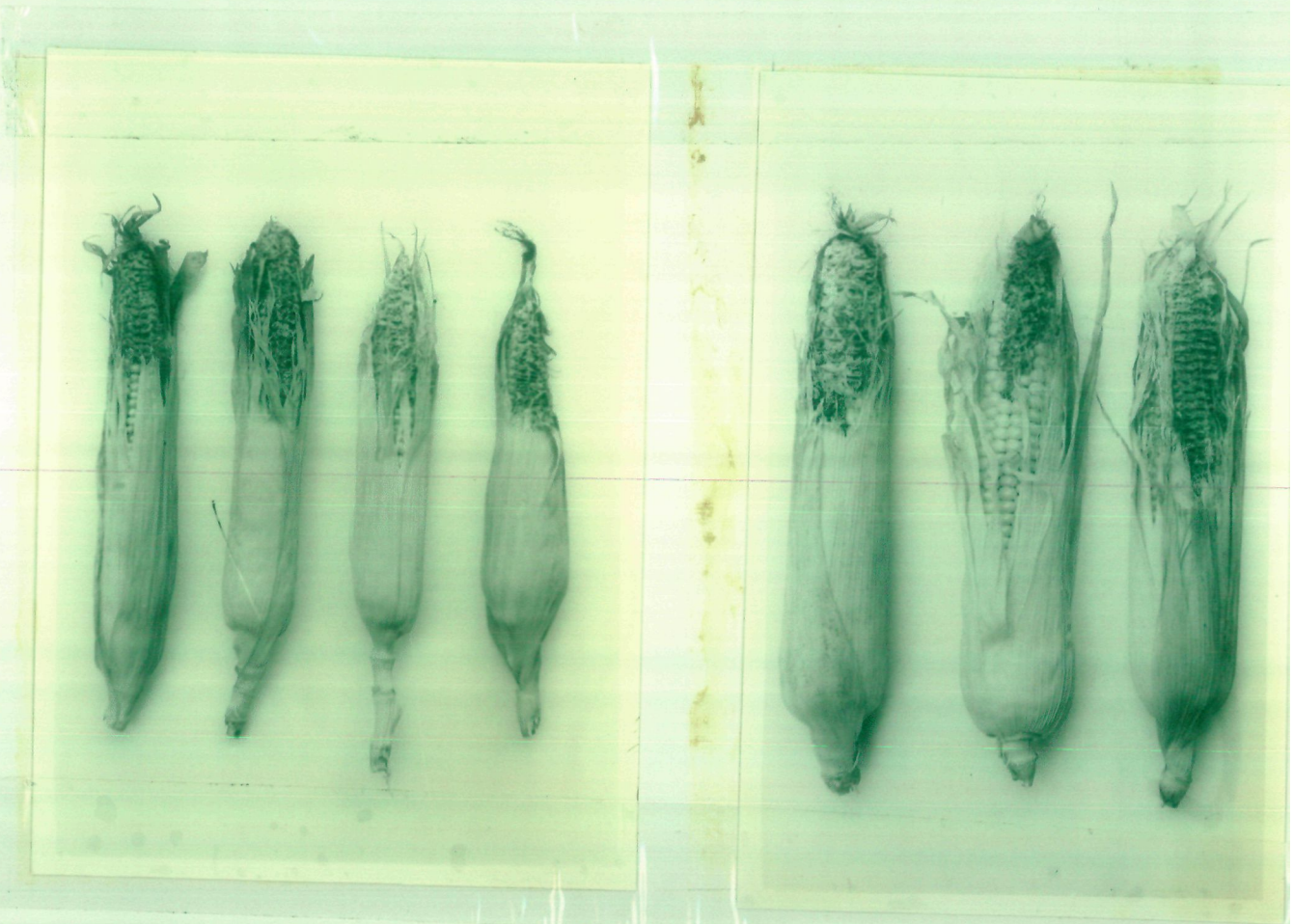


Plate 3(a)

Plate-3(b) Close-up of 3(a).

Plate 3(b)

the crop till the 21st days of germination. The damage to the seedlings was more towards the study area situated near the roosting place of the crows. The damage was first caused from 6.30 A.M. to 10.00 A.M. on normal days and upto mid days on cloudy and misty days. The second attack to the crop was from 3.30 P.M. till sunset. Detail observations revealed that the target was not the seedlings but the underlying food of the seeds. It was also noticed that the number of crows reduced in each week. This reduction in the number of crows explains the reduction in damage of the seedlings in each week. The visitants (crows) infesting this crop in various stages have also been recorded and presented in table 45.

Experimental plots

The total damage caused to the seedlings by House crows was between 0.27% and 3.63% (Table 42, Figs. 14 and 15). This damage was recorded for 21 days after the germination took place (Table 43 and 44, Figs. 16 to 21). The observations were taken in two consecutive years (1987 and 1988) and in both the years the damage in the first and third week was recorded less than the damage in the second week. In certain quadrats no damage was recorded at all in the first week. This explains that the ribbon had been very effective in the first week. The high damage to the seedlings in the second week elaborates the crows' adaptibility to the ribbon by that time. The less damage in the last week shows the low calorific and nutritive

TABLE - 42 :- DAMAGE (%) TO WHEAT SEEDLINGS BY HOUSE CROWS/WEEK AFTER GERMINATION.

YEAR		1987				1988			
AREA	WEEK	DAMAGE (%) QUADRAT NO.				DAMAGE (%) QUADRAT NO.			
		CONTROL		EXPERIMENTAL		CONTROL		EXPERIMENTAL	
		1	2	1	2	1	2	1	2
UF	Ist	13.32	16.14	0.00	0.00	12.63	12.74	0.00	0.00
	2nd	4.80	5.32	0.21	0.35	4.73	4.39	0.96	0.74
	3rd	1.00	0.95	0.06	0.11	1.48	1.57	0.14	0.32
	Total	19.12	22.41	0.27	0.46	18.84	18.70	1.10	1.06
BG	Ist	12.68	12.95	0.04	0.11	13.65	14.24	0.13	0.00
	2nd	5.08	4.76	0.54	0.56	5.62	5.62	0.43	0.41
	3rd	1.34	1.19	0.31	0.13	1.68	2.06	0.14	0.10
	Total:	19.10	18.90	0.89	0.80	20.95	21.92	0.70	0.51
CH	Ist	18.11	17.41	1.36	0.59	17.90	18.20	0.84	0.31
	2nd	4.25	7.68	1.36	1.67	7.17	6.57	2.94	3.27
	3rd	0.90	2.62	0.21	0.15	1.51	1.07	0.02	0.05
	Total	23.26	27.71	2.95	2.41	26.58	25.84	3.80	3.63

UF = Universityfarm, BG = Bhagwangarhi, CH = chherat
Control = Unprotected Experimental = Protected

TABLE - 43 DAILY DAMAGE (%) TO WHEAT SEEDLINGS BY HOUSE CROWS IN INTENSIVE STUDY AREAS (YEAR:1987)

	UNIVERSITYFARM				BHAGWANGARHI				CHHERAT			
	TOTAL DAMAGE(%)				TOTAL DAMAGE(%)				TOTAL DAMAGE(%)			
DAYS	QUADRAT NO.				QUADRAT NO.				QUADRAT NO.			
	CONTROL		EXPERIMENTAL		CONTROL		EXPERIMENTAL		CONTROL		EXPERIMENTAL	
	1	2	1	2	1	2	1	2	1	2	1	2
1.	3.19	3.14	0.00	0.00	2.42	3.27	0.00	0.00	4.13	3.94	0.00	0.00
2.	2.81	3.02	0.00	0.00	2.63	2.24	0.00	0.00	3.94	3.45	0.00	0.00
3.	1.67	2.69	0.00	0.00	2.29	2.16	0.00	0.00	2.91	3.27	0.00	0.00
4.	1.83	1.76	0.00	0.00	1.76	1.85	0.00	0.00	2.89	2.93	0.00	0.00
5.	1.42	1.79	0.00	0.00	1.27	1.46	0.00	0.00	1.79	1.07	0.00	0.00
6.	1.33	1.65	0.00	0.00	1.19	1.14	0.00	0.05	1.77	1.61	0.45	0.00
7.	1.07	2.09	0.00	0.00	1.12	0.93	0.04	0.06	0.68	1.14	0.91	0.59
8.	1.14	1.44	0.00	0.00	1.15	0.86	0.09	0.05	1.04	1.26	0.78	0.67
9.	0.91	0.89	0.07	0.00	0.94	1.03	0.00	0.09	0.93	1.18	0.29	0.54
10.	0.69	0.76	0.09	0.14	0.78	0.45	0.07	0.12	0.62	1.09	0.00	0.41
11.	0.64	0.79	0.03	0.07	0.64	0.93	0.15	0.18	0.58	1.34	0.07	0.00
12.	0.62	0.58	0.00	0.08	0.59	0.68	0.09	0.00	0.47	1.21	0.06	0.00
13.	0.39	0.47	0.00	0.04	0.52	0.39	0.09	0.00	0.32	0.93	0.18	0.03
14.	0.41	0.39	0.02	0.02	0.46	0.42	0.05	0.12	0.29	0.67	0.00	0.02
15.	0.36	0.31	0.02	0.01	0.43	0.62	0.08	0.06	0.31	0.62	0.21	0.09
16.	0.22	0.27	0.04	0.00	0.29	0.18	0.05	0.02	0.28	0.59	0.00	0.04
17.	0.17	0.11	0.00	0.03	0.16	0.09	0.00	0.05	0.08	0.47	0.00	0.02
18.	0.13	0.14	0.00	0.07	0.23	0.15	0.12	0.00	0.09	0.32	0.00	0.00
19.	0.08	0.07	0.00	0.00	0.12	0.00	0.06	0.00	0.05	0.29	0.00	0.00
20.	0.00	0.04	0.00	0.00	0.07	0.06	0.00	0.00	0.02	0.18	0.00	0.00
21.	0.04	0.01	0.00	0.00	0.04	0.09	0.00	0.00	0.07	0.15	0.00	0.00
Total	19.12	22.41	0.27	0.46	19.1	18.90	0.89	0.80	23.26	27.71	2.95	2.41

Control = Unprotected, Experimental = Protected

TABLE - 44 DAILY DAMAGE (%) TO WHEAT SEEDLINGS BY HOUSE CROWS IN THE INTENSIVE STUDY AREAS (YEAR:1988)

DAYS	UNIVERSITYFARM				BHAGWANGARHI				CHHERAT			
	TOTAL DAMAGE(%)				TOTAL DAMAGE(%)				TOTAL DAMAGE(%)			
	QUADRAT NO.				QUADRAT NO.				QUADRAT NO.			
	CONTROL		EXPERIMENTAL		CONTROL		EXPERIMENTAL		CONTROL		EXPERIMENTAL	
	1	2	1	2	1	2	1	2	1	2	1	2
1.	2.76	2.93	0.00	0.00	2.93	2.89	0.00	0.00	3.55	4.14	0.00	0.00
2.	2.79	2.53	0.00	0.00	2.85	2.64	0.00	0.00	3.46	3.79	0.00	0.00
3.	1.58	2.15	0.00	0.00	2.17	2.28	0.00	0.00	2.89	3.07	0.00	0.00
4.	1.52	1.49	0.00	0.00	1.94	1.81	0.00	0.00	2.97	2.91	0.00	0.00
5.	1.49	1.32	0.00	0.00	1.47	1.75	0.00	0.00	1.83	1.71	0.00	0.00
6.	1.17	1.18	0.00	0.00	1.12	1.79	0.08	0.00	1.76	1.73	0.00	0.00
7.	1.32	1.14	0.00	0.00	1.17	1.08	0.05	0.00	1.44	0.85	0.84	0.23
8.	1.21	1.04	0.00	0.00	1.24	1.19	0.07	0.00	1.46	1.12	0.95	0.56
9.	0.94	0.75	0.00	0.00	1.08	0.85	0.07	0.12	1.39	1.34	0.73	0.68
10.	0.76	0.62	0.15	0.00	1.09	0.88	0.04	0.09	1.22	1.26	0.65	0.83
11.	0.53	0.65	0.18	0.19	0.69	0.76	0.12	0.04	1.24	1.17	0.38	0.61
12.	0.54	0.59	0.23	0.27	0.54	0.64	0.11	0.07	0.89	0.79	0.18	0.27
13.	0.49	0.28	0.16	0.15	0.41	0.71	0.02	0.03	0.65	0.52	0.05	0.23
14.	0.26	0.46	0.24	0.13	0.57	0.59	0.00	0.06	0.42	0.37	0.00	0.09
15.	0.29	0.35	0.08	0.17	0.54	0.62	0.03	0.02	0.44	0.29	0.00	0.04
16.	0.24	0.21	0.02	0.09	0.49	0.48	0.05	0.00	0.36	0.21	0.02	0.00
17.	0.26	0.28	0.00	0.04	0.21	0.29	0.04	0.05	0.28	0.22	0.00	0.01
18.	0.31	0.17	0.04	0.00	0.19	0.15	0.00	0.00	0.14	0.18	0.00	0.00
19.	0.18	0.25	0.00	0.00	0.08	0.19	0.00	0.00	0.16	0.12	0.00	0.00
20.	0.11	0.19	0.00	0.02	0.13	0.27	0.02	0.03	0.09	0.02	0.00	0.00
21.	0.09	0.12	0.00	0.00	0.04	0.06	0.00	0.00	0.04	0.03	0.00	0.00
Total	18.84	18.7	1.10	1.06	20.95	21.92	0.70	0.51	26.58	25.84	3.80	3.63

Control = Unprotected, Experimental = Protected.

TABLE - 45 :- NUMBER OF CROWS OBSERVED AROUND THE CROP FIELD OF WHEAT AND THE NUMBER OF VISITANTS INFESTING THE CROP IN VARIOUS STAGES.

SPECIES AND POPULAR NAME	CORVUS SPLENDENS HOUSE CROW		CORVUS MACRORHYNCHOS JUNGLE CROW	
STAGES OF CROP DEVELOPMENT	1987-88	1988-89	1987-88	1988-89
Sowing	317/152*	296/224	59/05	42/13
Sprouting	671/324	589/433	42/11	31/09
Seedling	1013/636	691/452	51/13	69/12
Sapling	296/00	232/00	68/00	75/00
Fruit setting	391/00	456/00	72/00	191/00
Milky/Doughy	235/00	421/00	65/00	32/00
Ripening	476/00	282/00	59/00	41/00
Harvesting	351/00	417/00	76/00	85/00

* Upper figure in each column denotes the number of birds observed around the crop field and the lower figure indicates the number of bird visitants infesting the crop.

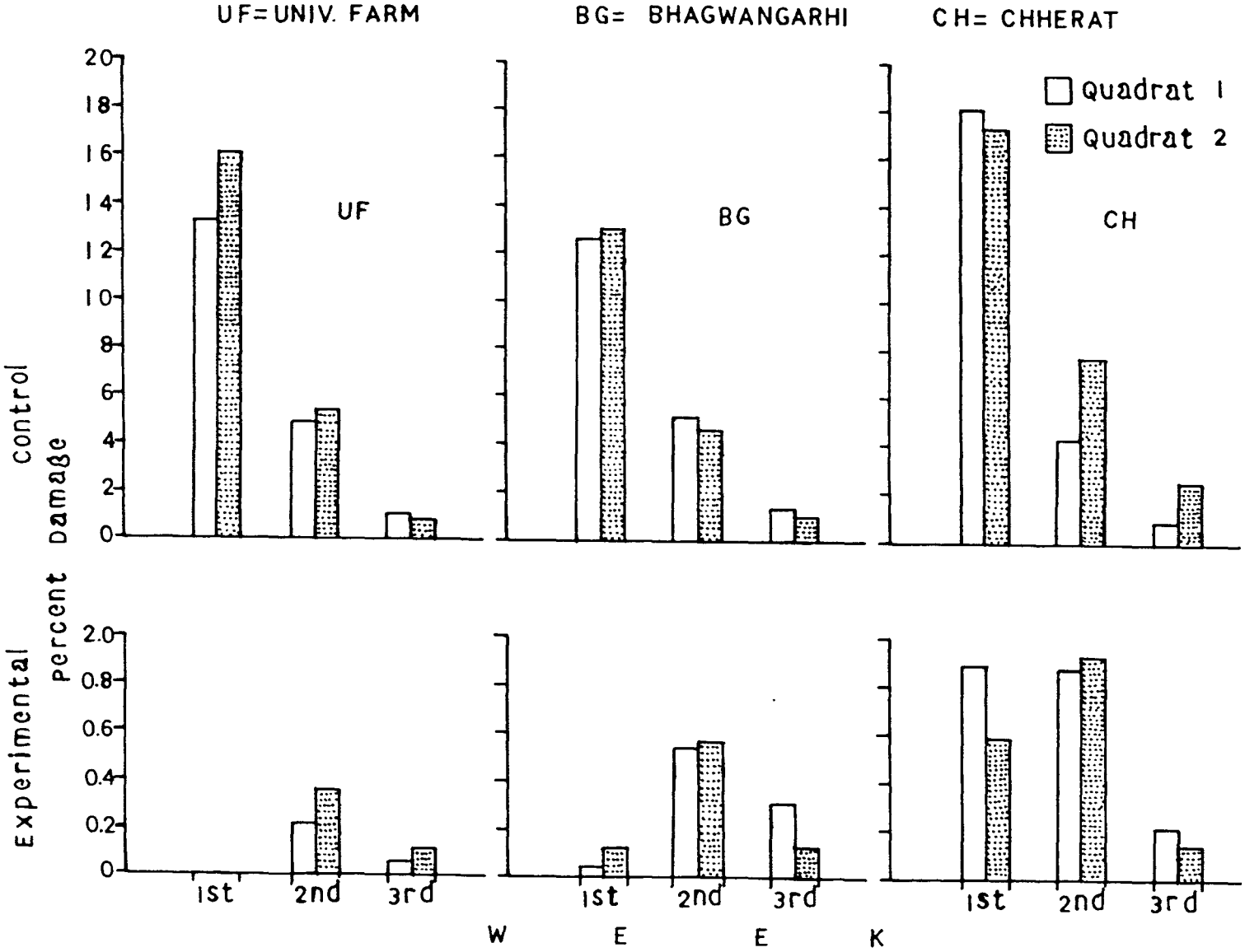


FIG. 14 DAMAGE (%) TO WHEAT SEEDLINGS BY HOUSE CROWS PER WEEK AFTER GERMINATION DURING 1987

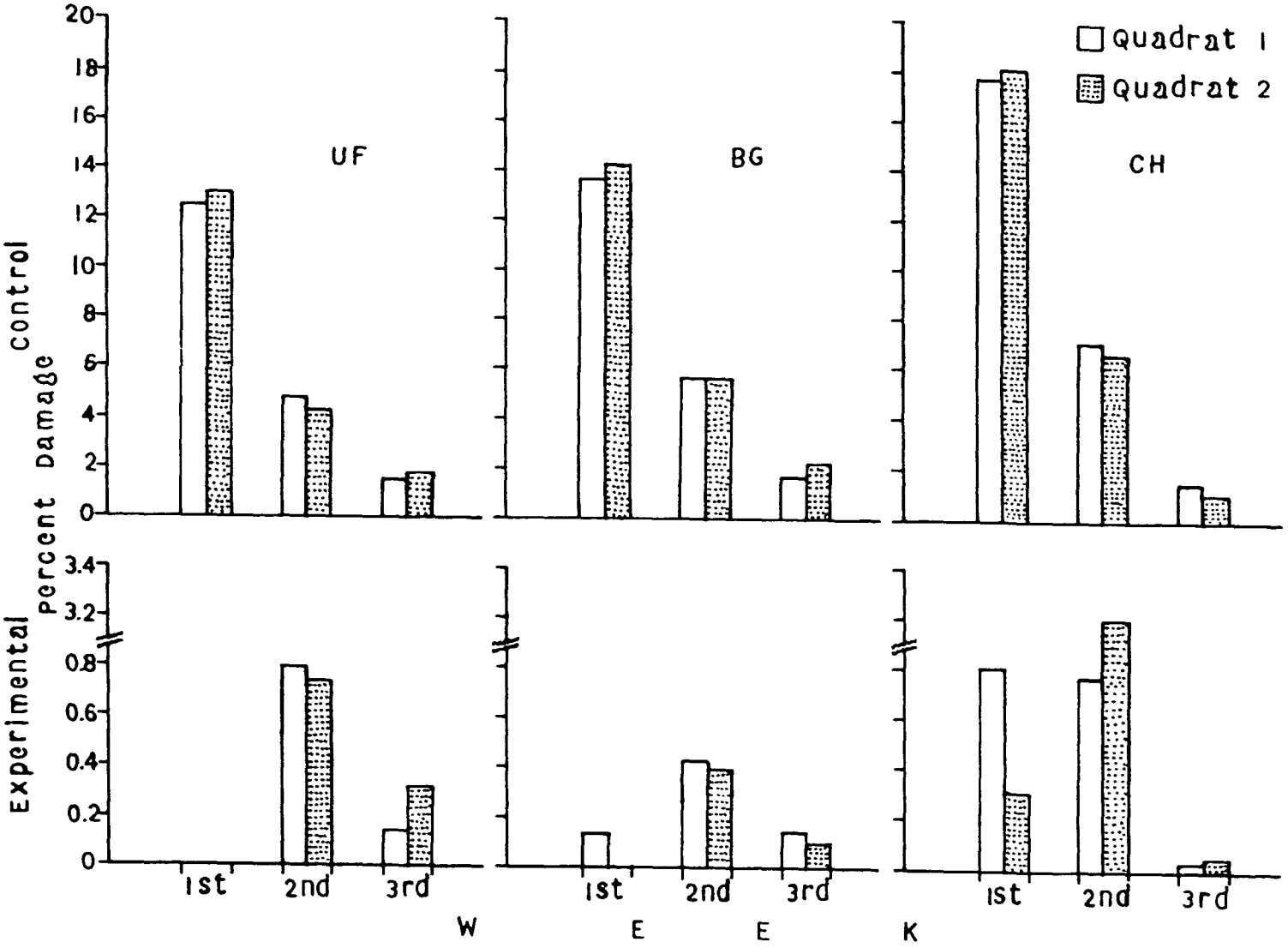


FIG. 15 DAMAGE (%) TO WHEAT SEEDLINGS BY HOUSE CROWS PER WEEK AFTER GERMINATION DURING 1988

UF= UNIV. FARM BG= BHAGWANGARHI CH= CHHERAT

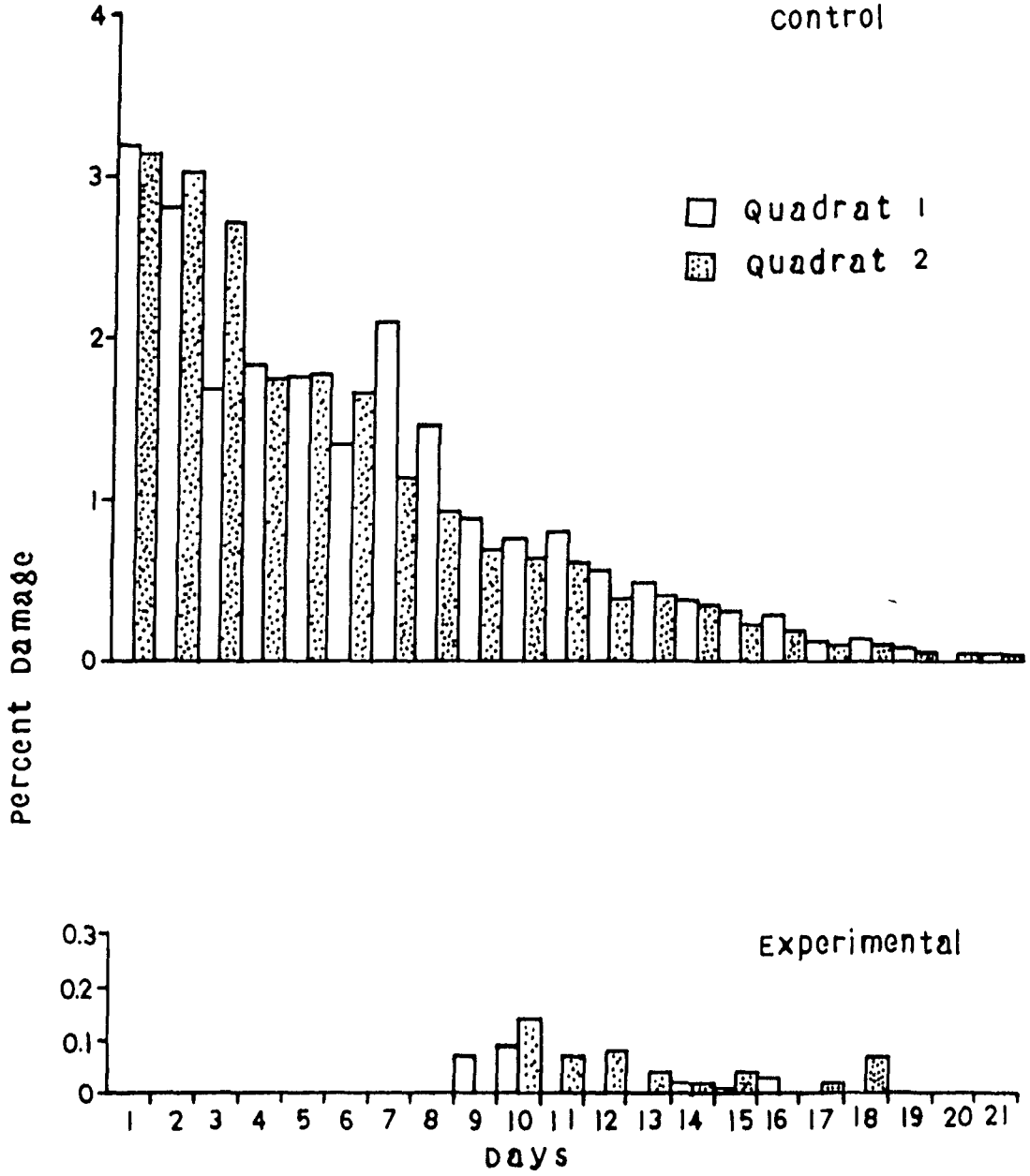


FIG. 16 DAILY DAMAGE % TO WHEAT SEEDLINGS BY HOUSE CROWS IN INTENSIVE STUDY AREA DURING 1987

AREA: UNIV. FARM

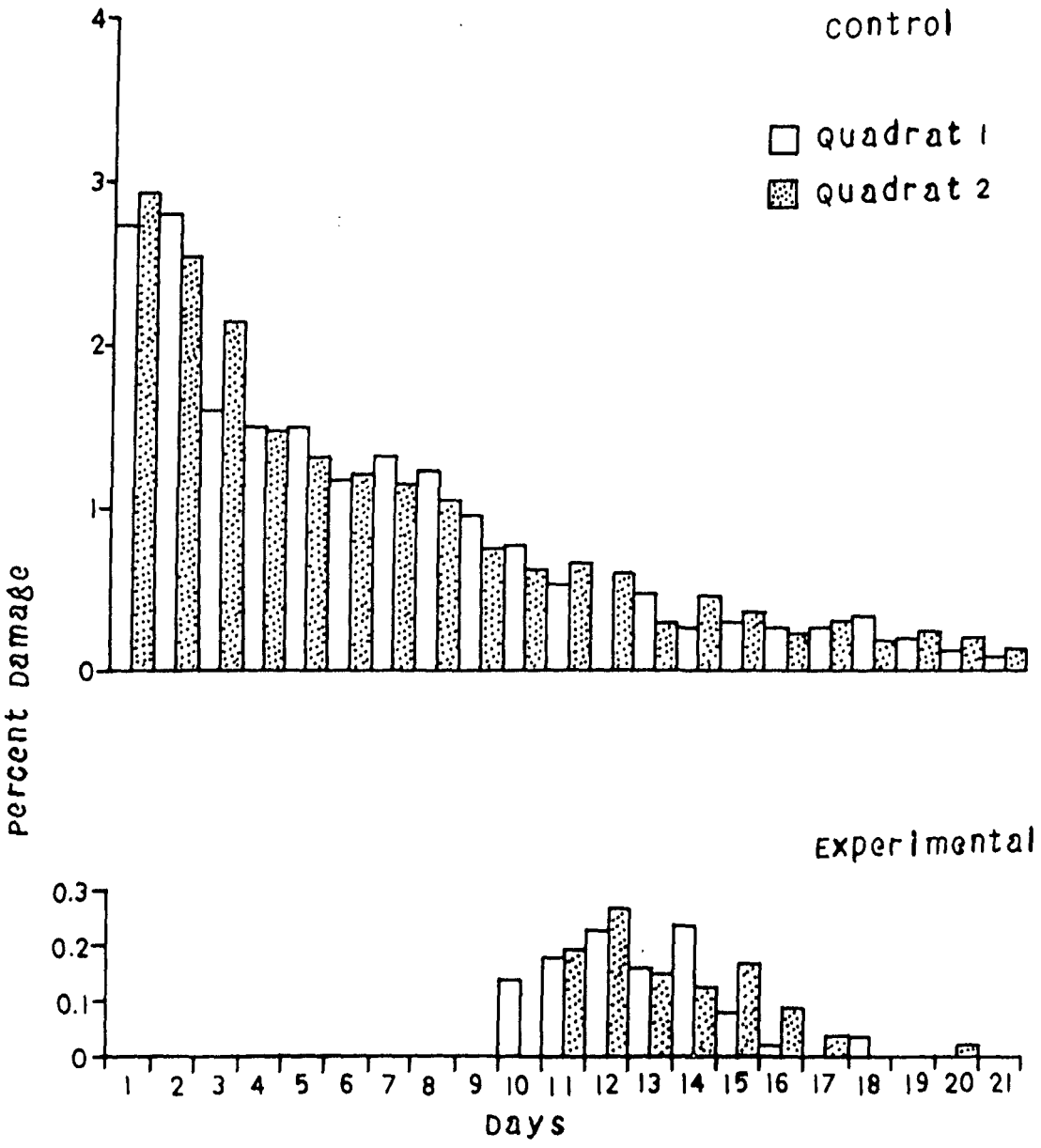


FIG. 17 DAILY DAMAGE % TO WHEAT SEEDLINGS BY HOUSE CROWS IN INTENSIVE STUDY AREA DURING 1988

AREA : UNIV. FARM

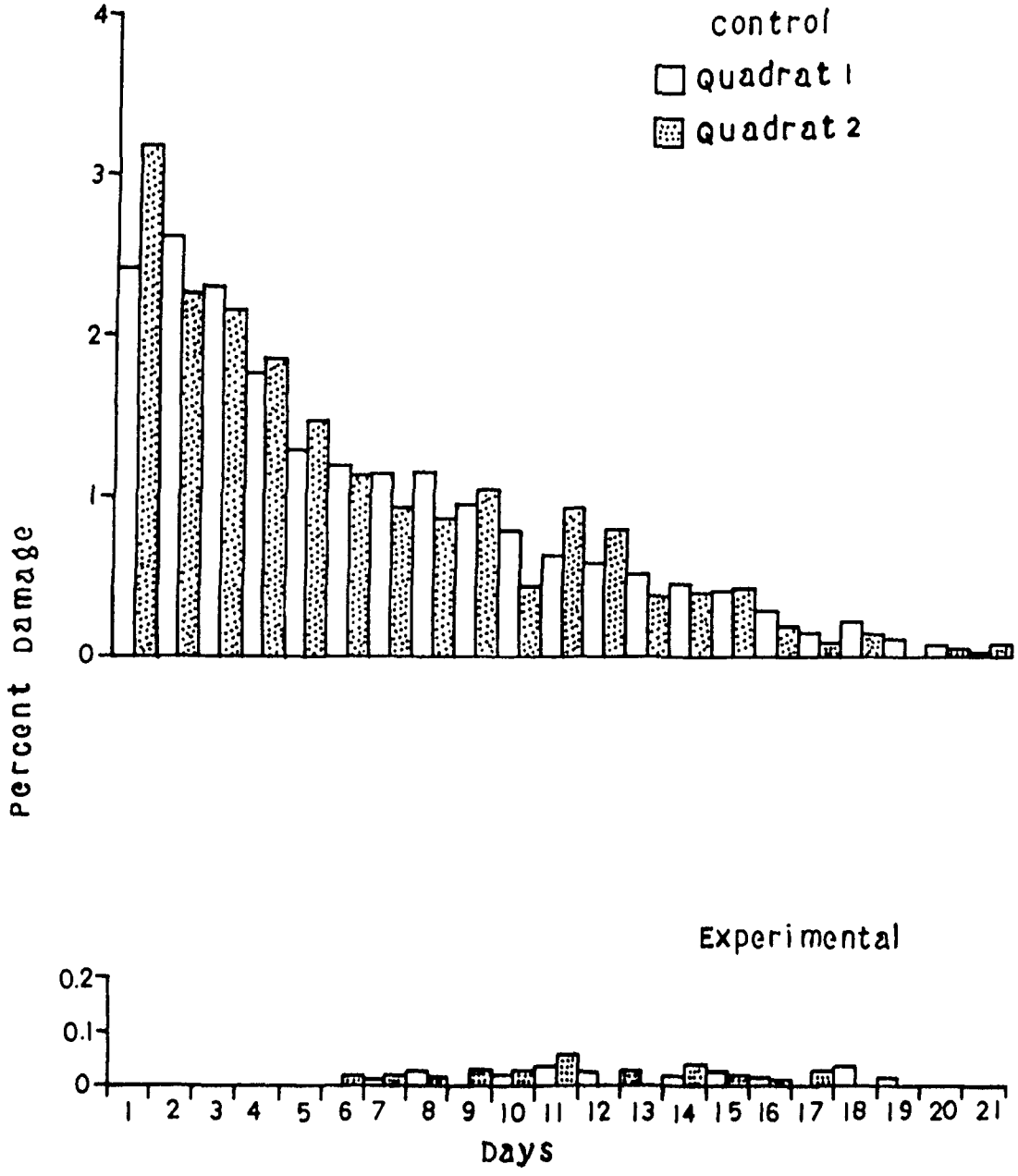


FIG. 18 DAILY DAMAGE % TO WHEAT SEEDLINGS BY HOUSE CROWS IN INTENSIVE STUDY AREA DURING 1987 Area: Bhagwangarhi

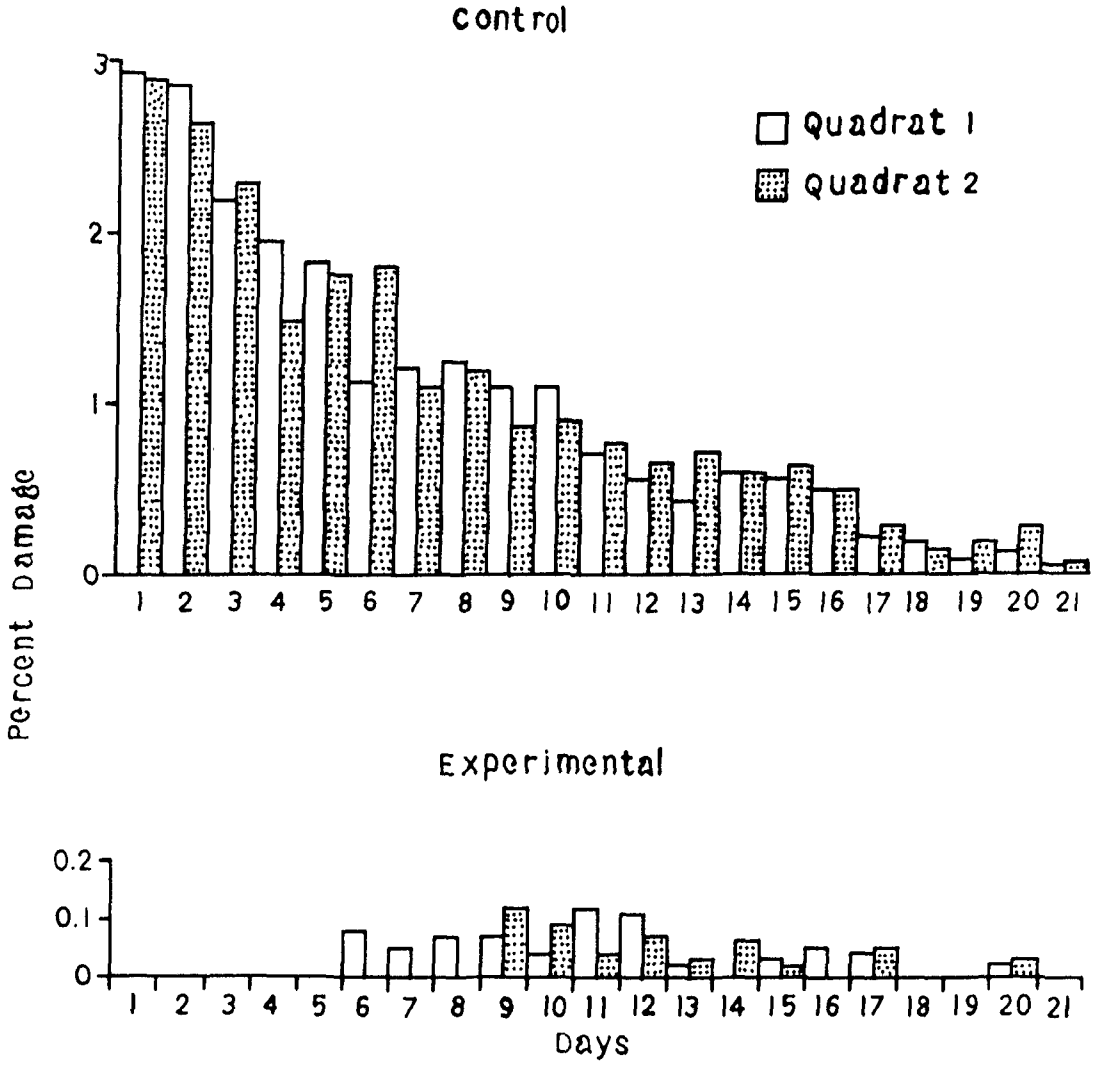


FIG.19 DAILY DAMAGE % TO WHEAT SEEDLINGS BY HOUSE CROWS IN INTENSIVE STUDY AREA DURING 1988

AREA: BHAGWANGARHI

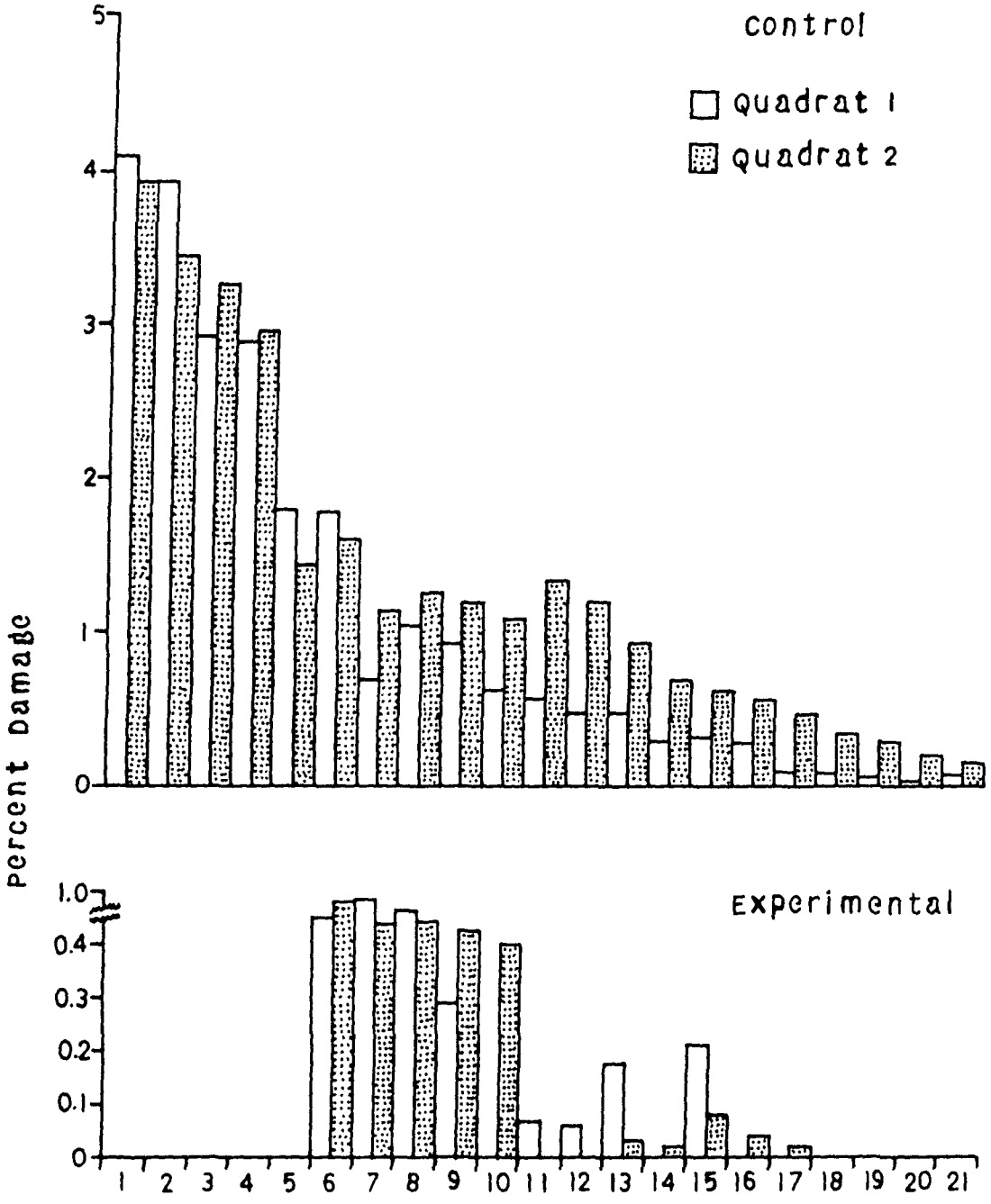


FIG. 20 DAILY DAMAGE % TO WHEAT SEEDLINGS BY HOUSE CROWS IN INTENSIVE STUDY AREA DURING 1987

AREA: CHHERAT

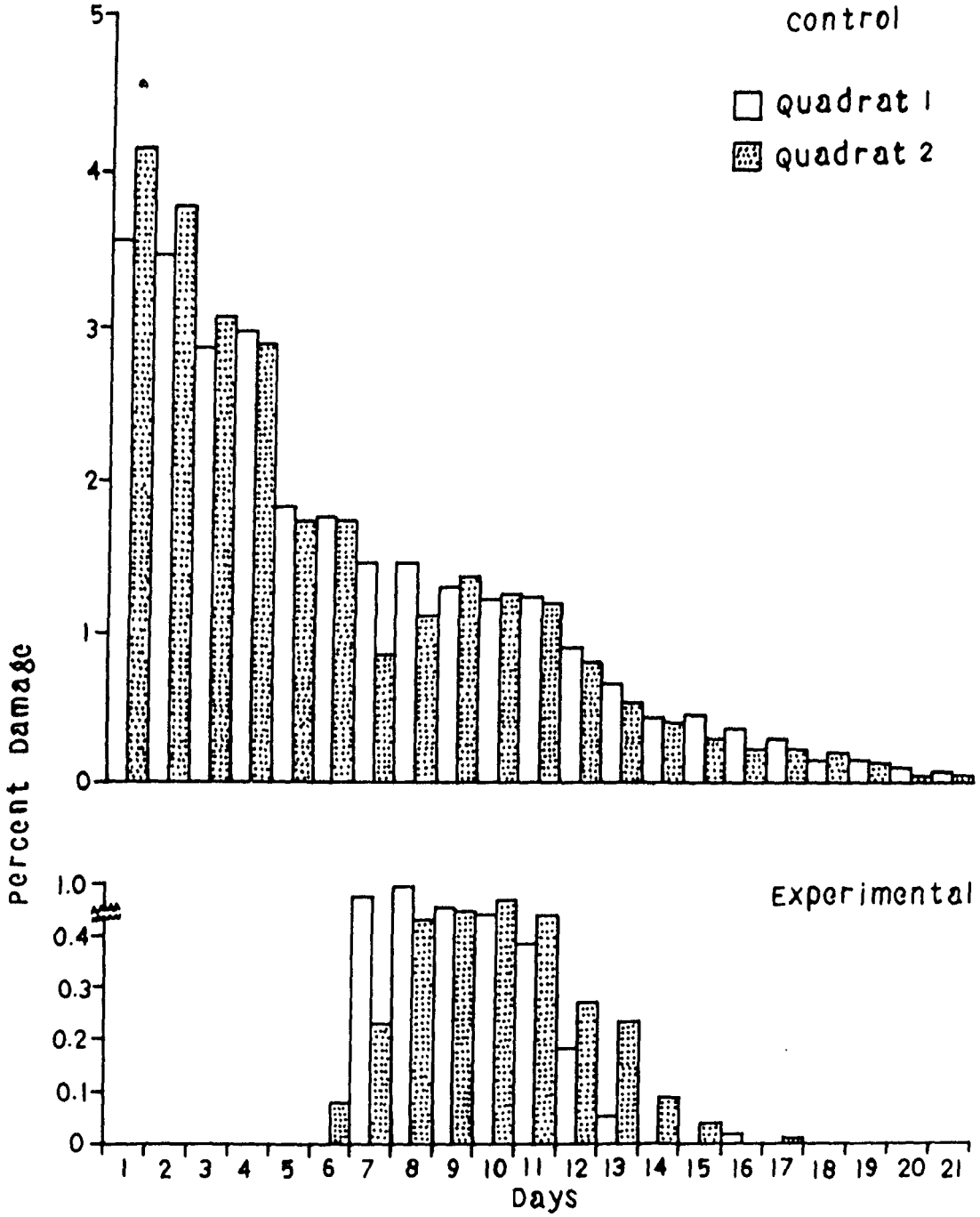


FIG. 21 DAILY DAMAGE % TO WHEAT SEEDLINGS BY HOUSE CROWS IN INTENSIVE STUDY AREA DURING 1988

AREA: CHHERAT

values of seeds during this week and also explains the reason why crows leave the area.

Damage assessment on mature wheat by different bird species

The result presented in table 46 shows that the weight loss in the earheads varied from 18.59 gm. to 41.26 gm. with an average wt. of 30.46 gm. per 100 earheads. An average wt. of grains expected was 159.00 gm. Thus the bird caused considerable damage to the earheads of the wheat and warrant its management. The recorded birds damaging the crop were the House sparrow, Baya-weaver birds and Roseringed parakeet, interestingly no damage by crows at this stage was observed.

Gut content analysis

Most of the information gathered on the food and feeding habits of the crows are based on direct and standard repeated observations in the study area. Before the study started it was planned to analyse a good number of gut contents. But due to certain limitations only six gut contents could be analysed by the end of the study period. The diet composition from the gut analysis is given in table 7. The analysis revealed that the bird is omnivorous. The recorded items include rice, wheat, guava seeds, traces of bones beetles, ticks and egg shells. Ramzan (1971) has done an indepth

Plate-4 Crows' roosting site - Eucalyptus groove.

Plate 4

TABLE - 46 DAMAGE (%) OF WHEAT/100 EARHEADS BY DIFFERENT SPP. OF BIRDS IN STANDING CROP.

PLOT	NO.OF EARHEADS DAMAGED	NO.OF GRAINS LOST IN DAMAGED EARHEADS	REMAINING GRAINS	EXPECTED WT. OF GRAINS	WT. LOSS
A	56	452	3188 (131.16)	149.75	18.59
B	47	611	3498 (143.92)	169.05	25.13
C	73	1003	2697 (110.96)	152.22	41.26
D	64	896	3114 (128.12)	164.98	36.86
Average				159.00	30.46

Figs.in parenthesis shows the wt. in gms.

study of gut contents of the crows and also found the birds to be omnivorous.

Relation to agriculture

The study revealed that the crows are omniphagous and they do not have any particular choice for a particular food item . They can eat whatever is eatable. However, they cause considerable damage to the seedlings of maize and wheat as well as to the mature grains of the maize. They also inflict damage to mature sorghum and Pearl millet by taking out the grains from their earheads but the loss should not be considered as economic loss to these crops (sorghum and Pearl millet) because they are basically grown by the farmers for the fodder purposes. But the wheat and the maize are the major crops of kharif and Rabi seasons as well. Therefore, their injury is the economic loss to the crops and the damage to these crops should be checked.

Damage to these crops can easily be reduced if it cannot be fully avoided. This can be done by scaring the birds away from the crop field at least during the first week of the germination of seeds.

In view of the above observations, the author can conclude that the useful activities of the crows seem to compensate these losses. However, the population of the birds must be checked to avoid even these economic injuries

they do to these crops.

Scavenging nature of crows

Apart from the damage assessment on the crops scavenging habit of crows could also be studied in some detail. This opportunity I could get at Chherat which was situated very near to the roosting site of the crows. The scavenging food items of the crows include carrion, offal, pork left in dumped skeleton and dung beetles. They could also be observed feeding on the human feaces. The data on their feeding activity on the above mentioned items were collected for 18 months and are presented in the table 47. It is evident from the table that the maximum number of the House crows as well as the Jungle crows were seen feeding on the above items. The next item on which they were found feeding in great number is the cattle dung. They were found feeding on dung in a party of 4-5 at the road sides or at the ground else where but at the dump they were recorded in group of 15-35 individuals. The party feeding on other items like carrion offal, pork and carcasses comprised of several groups (8-10) of 50-75 individuals. This made the overall population as about 600-750 scavenging at a particular time. Crows were found noticeably in higher numbers in morning and evening shifts than the noon shift through out the study period. The party of crows and other bird species scavenging at the dump has been shown in Plate 5(a)&(b), 6(a)&(b) and in 7.

Plate 5:(a)&(b) Crows scavenging on left over of pork.

Plate 5(a)

Plate 5(b)

Plate 6:(a)&(b) Crows and White - backed vultures scavenging on offal.

Plate 6(a)

Plate 6(b)

Plate-7 Crows and Egyptian vulture scavenging.

Plate 7

TABLE - 47 :- AVERAGE NUMBER OF BIRDS OBSERVED FEEDING ON DUNG, HUMAN FAECES AND OTHER FILTHS/WEEK IN EACH MONTH (OCTOBER,1987 TO MARCH,1989)

SPECIES AND POPULAR NAME	CORVUS SPLENDENS HOUSE CROW			CORVUS MACRORHYNCHOS JUNGLE CROW		
FOOD ITEMS	DN	HF	OFS	DN	HF	OFS
Oct. (1987)	19/14*	11/09	1323/1155	14/11	5/4	307/138
Nov. (1987)	23/21	7/05	1529/930	16/13	6/3	419/217
Dec. (1987)	35/29	10/08	1562/1192	20/15	09/5	425/269
Jan. (1988)	54/41	30/24	1427/1280	31/18	12/7	329/228
Feb. (1988)	47/29	32/18	1388/1091	37/25	15/9	289/221
Mar. (1988)	38/25	34/15	1512/1337	19/12	07/5	413/257
Apr. (1988)	68/11	18/11	1458/1315	25/09	11/06	352/211
May. (1988)	52/37	17/09	1612/1419	14/08	13/05	271/198
June. (1988)	29/13	12/05	1491/1327	27/12	18/04	415/311
July (1988)	34/17	18/11	1504/1319	26/15	15/09	297/192
Aug. (1988)	48/36	22/15	1314/1244	28/16	23/12	352/214
Sept. (1988)	35/26	16/12	1479/1335	14/09	08/06	390/237
Oct. (1988)	23/16	15/12	1392/1263	13/11	08/04	288/207
Nov. (1988)	38/31	17/14	1597/1351	17/12	12/07	382/229
Dec. (1988)	49/35	28/19	1671/1512	15/11	18/09	291/205
Jan. (1989)	60/51	39/31	1642/1566	26/17	19/11	324/229
Feb. (1989)	93/85	66/59	1866/1778	35/26	23/19	310/217
Mar. (1989)	71/54	35/23	1621/1471	46/31	30/22	214/187

DN = Dung, HF = Human faeces, OFS = Other filths (carrion, offal, pork left in dumped skeleton).

* Upper figure in each column denotes the number of birds observed near that food item and the lower figure indicates the number of bird species feeding on that.

It appears that though the crows do considerable damage to the crops, they also play very important role in nature and serve mankind by removing wastes and filths which otherwise may create unhygenic conditions.

Conclusion

Food and feeding habits of House crow has been studied in detail and it has been observed that they are harmful causing considerable damage to newly sown seeds as well as standing crops in the fields supporting the findings of Ramzan 1971, Toor and Sandhu 1979.

The House crow, though a useful scavenger is responsible for the damage to maize cobs, Jowar, Bajra, Groundnut, Fruits of Guava and riped mangoes. They do considerble damage to the seedlings of maize and wheat. They also feed upon bird nestlings, smaller birds like munias, wall lizards, eggs and various insects. It is important to mention that the shining ribbon was very promising in scaring birds away from the field. But it was effective only in the seedling stages, probably because of its visibility from a long distance and bird's less adaptibility due to its use for a very short period of time in the study area which otherwise had negative effect in the case of standing crops and been less effective

The farmers are not aware of the facts. They take

care of the crop and realize the damage only when they see by their own eyes. They do not take care of their crops after sowing. This is because they are unaware of the damage, the birds cause to the crops after sowing, so they should be made aware that to save the crop from depredatory species in the seedling stages rather than at maturity is more important. The study suggeststhat the crops should be protected in all stages of growing, specially in sprouting and the farmers should be instructed accordingly. The damage by birds is more apparent at maturity and during storages but considerable damage is done just after sowing nevertheless.

Management and control methods

Control of bird pests is a recent subject of study and is still in developmental stages even in advanced countries (Murton & Wright 1968 and Guarino, 1975). However few cases are known where control with varying degrees of success has been achieved (Wright, 1961 & 1968; Murton et. al. 1963; Romewell, 1966; Guarino & Schafer, 1967; Wornonecki et. al. 1967; Murton & Wright, (Edtrs.) 1968; Borough, 1968; Royall, 1969; Guarina & Forbes, 1970; Mott et. al., 1972; Mott, 1973; Degrazio et.al., 1973 & 1974). Bhatnagar (1976 a & b) has discussed the problem in some details. The available informations however, do give some basic informations (Singh & Duncan, 1956; Verma et. al. 1960; Ali S. 1963; Edtrs, 1963; Chopra et. al. 1972 and

Bindra & Tur, 1972; Filtzwater & Parakash, 1973; Chahal et. al., 1973; Sandhu & Simwat, 1973). Besides these certain studies deal briefly with the regional problems and emphasize upon population reduction of bird species. But this method can not be applied every where because the pest status of a number of bird species is still to be ascertained.

In case of birds, control methods are different than employed for other pest control operations due to flight, high intelligence, and high adaptibility. These factors involve several behavioural, ecological and biological factors which make bird control complex. Since the pest status of birds may vary from one region to another, different control approaches may have to be utilized for a particular bird species in different regions. However, the following methods may be fruitful and can provide sufficient protection to the crops from the depredating birds in this region.

General scaring

It is amongst the oldest methods of bird management leading to protection. It can be achieved by the use of sling shots, beating drums, scare-crow and shouts by men.

Cultural practices

It provides considerable protection from bird damage in crops (Anon,1952; Aldrich,1962; Edtrs.,1962; Buckley & Cottem,1966; Beri et. al.,1969; Kozicky & McCabe,1970;). Of various methods first step involves the protection of sown seeds. Other methods are cultivation of quick maturing variety to reduce exposure period to birds and pre or post dated sowing of the seeds.

Cultivation of bird resistant crop varieties appear equally promising cultural practice for protection. In sorghum Aldrich (1962) and Nichaus (1966) have shown that grains with higher tenin contents and sharp awns afford protection from bird depredations. In Bajra, the factors for resistence like awns and shed layers of anthers, have been shown to impart resistance to birds (Beri et. al., 1969). Maize varieties with tight husk are reported less susceptible to bird attack (Anon,1962). In wheat too the varietal susceptibility has been studied earlier by Ambastha (1962) and by Bhatnagar et. al., (1973).

Bio-acoustics

This involves utilization of bird calls like warning and distress cries to bring about the dispersal of the depredatory species. Birds call can be variously used viz. for collecting them at a desired source by replaying their

feeding and assembly calls or dispersal by replaying their distress and warning cries. This method may show promising usages against our major pest species like Crows, Pigeons, Parakeets and Sparrows.

Stupefying Substances

These substances have been tried in the form of feeding baits or in drinking stations for bird management. These substances effect the Cerebro-cortical region of brain (Daude,1942 and Hariere,1943) causing temporary immobilization. The method offers some selectivity and possibility by releasing the unwanted species of birds. The small dosages of these chemicals induce behavioural changes like erratic flying and flattering which also aide in dispersal. These substances have drawn wide attention of workers abroad and details of which are available from excellent review by Ridpath et. al. (1961). In India, however, studies on stupefying compounds have not been undertaken and deserve attention. Efforts should be directed to study the biological activities of compounds on Indian species which may lead to finding of some suitable repellent aginst Indian depredatory species like Crows, Parakeets, Pigeons etc.

Frightening Substances

These substances in the form of baits or in water

on ingestion induce erratic behaviour and eventually induce fright in birds which brings about their dispersal. Often few individuals of the flock are affected which bring about the dispersal of rest of the flock due to their frightening behaviour. The use of frightening agents in bird control started in 1962, when Goodhue et. al. (1964) observed fright induction in Sparrow (Passer domesticus) due to the effect of 4-aminopyridine. The fright behaviour involved, ascending (up to 500) in circular flights with cries which brought about disperdsal of the rest of the flock (Goodhue & Baugertner, 1965).

Scaring ribbon

The shining ribbon of aluminium foil is very promising when it is used in the seedling stages of the crop development. But there are two great limitations for the farmers to use this ribbon. Firstly it is not easily available in the market. Secondly the cost of the ribbon is too high to afford by the farmers.

REFERENCES

Ali, Salim '1936' Economic ornithology in India Curr. Sci. Bangalore, 4: 472-478.

Ali, Salim and Ripley, S.D. '1983' Hand book of the Birds of India and Pakistan, Compact Edition, Oxford University Press, Bombay.

Agarwal, R.A. and Bhatnagar, R.K. '1982' Management of Problem Birds in Aviation & Agridulcture. Proc. Seminar on Management of Problem Birds in Aviation & Agriculture.

Ali, Mir Hamid, Krishnamurthy Rao, B.H., Ananada Rao M. and Syamsunder Rao, P. '1982' Bird damage in maize. Reprint from J. Bombay nat. Hist. Soc. 79'1' '201-204'.

Crase, Frederick T. and Dehaven, Richard W. '1978' Food Selection by five Sympatric California Black bird species. Reprint from Calif. Fish and Game, 64'4' : 255 - 267.

Coleman, J.D. '1974' Breakdown rates of foods ingested by Starlings. J. WILDL. MANAGE. 38'4' : 910-912.

Coleman, John S. and Fraser, James D. '1987' Food habits of black and Turkey Vultures in Pennsylvania and Maryland, J. WILDL. MANAGE. VOL 51, NO.4, P 733 - 738.

Dixit, Dhruv '1968', Crows and Companionship. Reprint from J. Bombay nat. His. Soc. 65'2' : 487 - 488.

Dhindsa, M.S., Toor, H.S. and Sandhu, P.S. '1984' Community Structure of Birds damaging Pearl Millet and Sorghum and Estimation of grain loss. Indian J. Ecol. 2 '1' : 154 - 159.

Dhindsa, M.S. and Sandhu, P.S. '1984', Morphometric variation in a population of the House Crow **Corvus splendens**, Le Gerfaut 74 : 139.144.

Dhindsa, M.S. and Toor, H.S. '1980' Extent of bird damage to rice nurseries in the Punajab and its control. Indian j. agric. Sci. 50'9' :715-719.

Dhindsa, M.S., Saini, Manjit S. Sandhu, Jaswinder S. and Toor, H.S. '1985' Bird Community associated with Indian coral tree **Erythrina indica** during the peak floworing period. Indian J. Ecol., 12'2' : 216 - 222.

Fowler, Jim and Cohen, Louis '1986' Statistics for Ornithologists, British Trust for Ornithology.

Gole, Prakash V. '1975' Tawny eagle as a scavenger. Reprint from J. Bombay nat. Hist. Soc. 71 '2' : 302 -303.

Hand book of Agriculture '1987' Indian Council Agricultural Research, N. Delhi, Published by ICAR, N. Delhi.

Hartley, P.H.T. '1948' The assessment of the food of birds. The Ibis. Vol. 90, No.3.

Meise, W. '1975' Grzimek's Animal Life Encyclopedia Vol.7 Birds I.

Mehrotra, K.N. and Bhatnagar, R.K. '1979'. Status of Economic Ornithology in India : Bird depredents, depredations and their management. Monograph ICAR, N. Delhi.

Mathew, D.N., Narendran, T.N. and Zacharias, V.J. '1980' A comparative study of the feeding habits of certain species of Indian Birds affecting agriculture. J. Bombay nat. Hist. Soc. 75 : 1178 - 1197.

MCATE, W.L. '1912' Methods of estimating the contents of bird stomachs. Auk. Vol. 29 : 449 - 464.

Moeed, Abdul '1980' Diets of adult and nestling Starlings **Sturnus vulgaris** in Hawke's Bay, New Zealand. New Zealand J. of Zoology. Vol.7., 247 - 256.

Muthukrishnan, T.S. and Sundarbabu, Rajeswari '1982' Feeding habits of Copper-smith **Megalaima haemacephala** 'Muller'. Reprint from J. Bombay nat. Hist. Soc. 79 '1' '197 - 198'.

Moeed, Abdul and Fitzgerald, B.M. '1982' Foods of insectivorous birds in forest of Orongorongo Valley, Wellington, New Zealand, New Zealand J. of Zoology Vol. 9 : 391 - 403.

Manning, A.W.G. '1973' An Introduction to Animal Behaviour. The English Language Book Society and Eeward Arnold 'Publishers' Ltd.

Narang, M.L. and Lamba, B.S. '1980' Methods of assessment of the food intake of birds with special reference to two species of Indian Mynas. Proceeding Wildlife Workshop, 133 - 140.

Narang, M.L. and Lamba, B.S. '1982' A contribution to the food-habits of Greyheaded Myna, **Sturnus malabaricus malabaricus** 'Gmelin' Indian J. of Forestry Vol. 5 '1', 24 - 29.

Parasharya, B.M., Dodia, J.F., Yadav, D.N. and Patel, R.C. '1986' Sarus Crane Damage to Paddy Crop. Pavo, Vol. 24, Nos. 1 and 2, pp 87 to 90.

Purchas, T.P.G '1980' Feeding ecology of rooks **Corvus frugilegus** on the Heretaunga plains, Hawke's Bay, New Zealand. New Zealand J. of Zoology, Vol. 7, 557 - 578.

Pitts, T. David '1979' Foods of Eastern Blue birds during exceptionally cold weather in Tennessee. J. WILDL. MANAGE. Vol. 43 No. 3 : 752 - 753.

Perrins, C.M. and Birkhead, T.R. '1982' Avian Ecology; Tertiary Level Biology. Blackie & Son Limited, Glasgow and London, Chapman and Hall, New York.

Pettingill, Jr. Olinsewall '1985' Ornithology in Laboratory and Field. Cornell University, Ithaca, New York.

Ripley, S.D. '1961' A synopsis of the birds of India and Pakistan : Bombay nat. Hist. Soc. Bombay.

Singh, R.L. '1987' India : A Regional Geography, National Geographical Society of India.

Tinbergen, N. '1954' Bird Life : Oxford University Press, London.

Toor, H.S. and Sandhu, P.S. '1981' Bird damage to Peach. **Prunus persica** Batsch. Indian J. Ecol. Vol.8: 308 - 310.

Toor, H.S., Kaur, H. and Dhindsa, M.S. '1986' Community structure and feeding ecology of birds at a grain store in Punjab 'India', Trop. Sci. 26, 233 - 247.

Toor, H.S. and Sandhu, P.S. (1979) Note on the extent of losses caused by the House-Crow to wheat seedlings at Ludhiana. Indian J. agric. Sci. 49 (10) : 817.

Van Tyne, J. and Berger, A.J. (1971) Fundamental of Ornithology, Dover Publication Inc. New York.

Wust, W. (1984) Grzimek's Animal Life Encyclopedia, Vol.9, Birds III.

Welty, J.C. (1979) The Life of Birds Saunders College Publishing, Philadelphia.

Yahya, H.S.A. (1980) Ecology and Breeding Biology of Barbets at Periyar Tiger Reserve, Ph.D. Thesis, Bombay University, Bombay.

APPENDIX - I

List of Abbreviations:

cm	Centimeter
et al.	et alu (= and others)
Fig.	Figure
gm	Gram
i.e.	Id est (=that is)
J.	Journal
MANAGE	Management
nat.	Natural
Proc.	Proceeding
pp	Pages
Sci.	Science
Soc.	Society
VOL	Volume
Viz.	Videlicet (= namely)
WILDL	Wildlife
Wt.	Weight
/	per

APPENDIX - II

VEGETATION OF THE STUDY AREA

Herbs and Shrubs:

Scientific names	Seasonality	Description
Capparis sepiaria	Perennial	Shurb, spiny, ,xerophytic.
Capparis decidua	Perennial	Shrub, spiny,leafless 'leaves in monsoon'
Abrus precatorius	Perennial	Shrub/climber,found in dry scrub forest, flowering in monsoon, fruiting in winter.
Cocculus hirsutus	Summer-Monsoon	Shrub/climber,found in dry scrub forest.
Trianthema portulacastrum	Monsoon	Herb/succulent common weed.
Achyranthes aspera	Summer-Monsoon	Herb,mesophyte,common weed.
Corchorus aestuans	Monsoon	Herb, common weed.
Boerhavia diffusa	Monsoon	Herb/Prostate,common.
Gomphrena celesioides	Summer-Monsson	Herb/globular,common in grassfields.
Crotalaria medicaginea	Monsoon-Early winter	Herb,common weed on wasteland.
Indigofera linnaei	Monsoon	Herb,common on grass land.
Indigofera linifolia	Monsoon	Herb,common on grass land and wasteland.
Celosia argentea	Monsoon	Herb,common weed in kharif crops cultivations.

appendix II, continued:

Alysicarpus monilifer	Monsoon	Herb/mesophyte,common on grassland and wasteland.
Justicia diffusa	Monsoon	Herb,common on moist/ grassland.
Oldenlandia corymbosa	Monsoon - Early winter	Herb, small, common on grassland.
Commelina bengalensis	Monsoon	Herb/succulent,common on moist places.
Borreria articularis	Monsoon	Herb,common/weed on grassland.
Alternanthera pungens	Monsoon	Herb, common weed on roadside and wasteland.
Cassia pumila	Monsoon	Herb, small, delicate, common on grassland.
Fumaria indica	Winter	Herb, common weed in Rabi/wheat fields.
Stellaria media	Winter	Herb,common weed in lawns and wasteland.
Melilotus indica	Winter	Herb,common weed on wasteland.
Melilotus alba	Winter	Herb, not very common, weed.
Gnaphalium indicum	Winter	Herb, common weed in moist places and near drains.
Veronica anagallis	Winter	Herb,common in moist places and near drains.
Chenopodium album	Winter	Herb/succulent,common weed on wasteland.
Asphodelus tenuifolius	Winter	Herb/succulent,common weed in wheat fields and wasteland.
Potentilla supina	Winter	Herb,common weed in shade.

appendix II, continued:

Trigonella corniculata	Winter	Herb,common weed in wheat fields.
Capparis zeylenica	Perennial	Shrub/scandent/ xerophytic.
Carissa spinarium	Perennial	Shrub,small,xerophytic.
Flacourtia indica	Summer/Monsoon	Shrub, large/medium, xerophytic, common in dry scrub forest.
Clerodendrum phlomidis	Monsoon-Winter	Shrub, large,mesophytic common.
Zizyphus oenoplia	Winter-Summer	Shrub,scandent,xeric.
Mimosa hamata	Perennial	Shrub, common,xeric.

Grasses:

Lolium temulentum	Winter	Common allover.
Poa annua	Winter	Common in moist and shady places.
Phalaris minor	Winter	Common in wheat fields and rabi crops.
Heteropogon contortus	Winter	Common in wastelands.
Erianthus ravennae	Perennial	Common along railway line and roadside.
Apluda aristata	Winter	Common on wasteland.
Iseilema laxum	Winter	Common on wasteland.
Sporobolus diander	Summer	Hardy, tough grass, common on saline and user land.
Dactyloctenium aegyptium	Monsoon and summer	Hardy,stout grass, common on wasteland.
Setaria verticillata	Monsoon	Hardy, stout,less common.

appendix II, continued:

Setaria glauca	Monsoon	Dwarf,less common.
Dicanthium annulatum	Monsoon	Abundant on wasteland and grass-fields.
Demostachya bipinnata	Monsoon	Large, stout,common on wasteland.
Chloris barbata	Monsoon and Summer	Large,stout,only on wasteland and dilapidated walls.
Vetiveria zizanioides	Monson to Winter	Known as Khus,common near stagnant water bodies.

Trees:

Scientific names	Common names	Description
Azadirachta indica	Neem	Very common
Dalbergia sissoo	Sheesham	Very common
Syzygium cuminii	Jamun	Common
Ficus benghalensis	Bargad	Less common
Ficus religiosa	Peepal	Less common
Ficus virens	Pilkhan	Less common
Ficus racemosa	Gular	Less common
Bombax ceiba	Semal (Silk Cotton)	Less common
Terminalia arjuna	Arjun	Less common
Terminalia belerica	Behra	Less common
Polyalthia longifolia	Ashok	Common
Bauhinia verigata	Kachnal	Less common
Jacranda mimosifolia	Jacranda	Not common

appendix II, continued:

Tamarindus indica	Imli	Not common
Butea monosperma	Dhak	Not common
Albizzia procera	Safed siris	Not common
Albizzia lebbeck*	Siris	Not common
Pithecellobium dulce	Jangal Jalebi	Less common
Acacia nilotica Sub-sp. indica	Babool, Kikkar	Very common

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* House crow found feeding on the seeds.